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TRANSACTIONS

OF THE

New England

COTTON MANUFACTURERS' ASSOCIATION.

Founded April 20, 1865. Incorporated Dec. 1, 1894.

NO. 72.

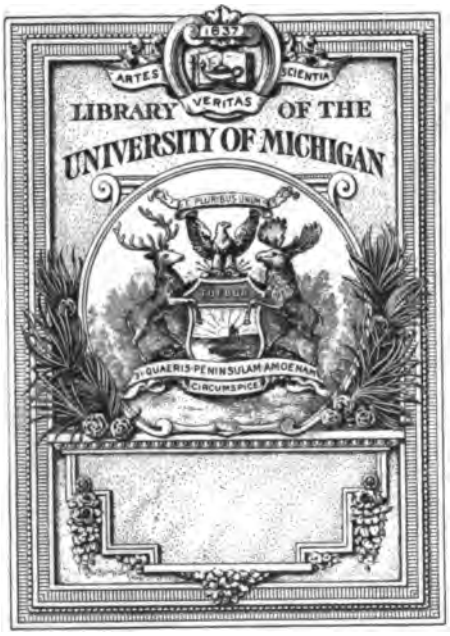
ANNUAL MEETING.

Held in Chipman Hall, 88 Tremont Street, Boston, Mass.

APRIL 23-24, 1902.

Office of the Association:
Room 57, International Trust Building, 45 Milk Street,
Corner of Devonshire St., Boston, Mass.

WALTHAM, MASS.:
PRESS OF C. L. BARRY.
1902.



THE GIFT OF

Association

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1550
.N2

NEW ENGLAND

Cotton Manufacturers' Association.

Proposal for

.....

Membership of

Notice to Members.

To make the Cotton Manufacturers' Association an absolutely representative body it must include as many as possible of those who are eligible for membership. It has been found that many who were eligible and desired to join had not done so because not invited. It is hoped that every member will present the matter to non-members among his associates. The accompanying blank proposition for membership can be detached from the cover at the row of perforations.

NEW ENGLAND

Cotton Manufacturers' Association.

Proposal for

.....

Membership of

.....

Application Received

....190 .

Action by Board of Government,.....favorable.

.....190 .

Voted by the Association,..... elected.

.....190 .

New England
Cotton Manufacturers' Association.

Room 57, International Trust Building,

45 MILK STREET,

BOSTON, MASS.

PROPOSAL FOR MEMBERSHIP.

(When filled out, to be mailed to the Secretary, P. O. Box 3672, Boston, Mass., in time for action by the Board of Government, at least one week before a meeting of the Association.)

Mr. .....

Position, ...

P. O. Address, ...

is proposed for ..... *membership in the* NEW ENGLAND COTTON
active or associate

MANUFACTURERS' ASSOCIATION *by* .....
signature of member proposing candidate.

a member of the Association.

Experience of Applicant, (Please state, in full, particulars of detail, giving names, dates, and nature of work, as fully as convenient.)

.....

.....

.....

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.....

.....

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.....

The undersigned certifies that the above statements are correct, and agrees that, if elected to the Association, he will be governed by its rules as long as his connection with it shall continue.

Date, ... 190 .

.....
signature of candidate.

TRANSACTIONS

OF THE

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Room 57, International Trust Building, 45 Milk Street,
Corner of Devonshire St., Boston, Mass.

WALTHAM, MASS.:
PRESS OF E. L. BARRY,
1902

ENTERED ACCORDING TO ACT OF CONGRESS
IN THE YEAR 1902
BY THE NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
IN THE OFFICE OF THE LIBRARIAN OF CONGRESS
AT WASHINGTON.

By vote of the Board of Government, the price of the *Transactions* is $5.00 per copy to non-members. The price of this issue and the one previous is $1.00 each to members, and the prices of copies previous to Volume 61, is 50 cents to members, but each member is entitled to a copy as a part of the privilege of membership.

CHARTER.

No. 6091.

Commonwealth of Massachusetts.

BE IT KNOWN, That whereas, EDWARD W. THOMAS, C. J. H. WOODBURY, WILLIAM J. KENT, F. M. MESSENGER, HARRY T. WHITIN, ARTHUR H. LOWE, ALBERT F. KNIGHT, ALFRED M. GOODALE, FRED C. MCDUFFIE and GEORGE W. BEAN have associated themselves with the intention of forming a corporation under the name of the NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION, for the purpose of encouraging scientific investigation and experiment as to the methods of manufacturing cotton; collecting and imparting information relating to this industry, promoting social intercourse among its members; and establishing and maintaining a library of works on textiles in the city of Boston, and have complied with the provisions of the Statutes of this Commonwealth in such case made and provided, as appears from the certificate of the President, Treasurer and Directors of said corporation, duly approved by the Commissioner of Corporations, and recorded in this office.

Now, Therefore, I, WILLIAM M. OLIN, Secretary of the Commonwealth of Massachusetts, do hereby certify that said EDWARD W THOMAS, C. J. H. WOODBURY, WILLIAM J. KENT, F. M. MESSENGER, HARRY T. WHITIN, ARTHUR H. LOWE, ALBERT F. KNIGHT, ALFRED M. GOODALE, FRED C. MCDUFFIE and GEORGE W. BEAN, their associates and successors, are legally organized and established as and are hereby made an existing corporation under the name of the

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,

with the powers, rights and privileges, and subject to the limitations, duties and restrictions which by law appertain thereto.

Seal of the Commonwealth of Massachusetts.

Witness my official signature hereunto subscribed, and the seal of the Commonwealth of Massachusetts hereunto affixed this first day of December, in the year of our Lord one thousand eight hundred and ninety-four.

WILLIAM M. OLIN,

Secretary of the Commonwealth.

157072

Commonwealth of Massachusetts.

(Acts of 1895, Chap. 163.)

AN ACT TO AUTHORIZE THE NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION TO HOLD ITS MEETINGS WITHOUT THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. The New England Cotton Manufacturers' Association is hereby authorized to hold its meetings in any state or territory of the United States and in the District of Columbia; provided, however, that its annual meeting shall be held in this Commonwealth at least once in five years.

SECT. 2. This act shall take effect upon its passage. [Approved March 23, 1895.]

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION.

FOUNDED APRIL 20, 1865.

INCORPORATED DECEMBER 1, 1894.

CONSTITUTION AND BY-LAWS.

ACTIVE MEMBERS.

ARTICLE 1. Any person who is actively engaged as President, Treasurer, Agent, Superintendent or Manager in the manufacture, printing or finishing of cottons shall be eligible for active membership.

ELECTION OF MEMBERS.

ARTICLE 2. All nominations for membership shall be made in writing, at least one week before the date of any regular meeting, and shall be considered by the Board of Government, and reported to the meeting, favorably or adversely, for the action of the Association. *Provided*, that in case the Board shall decide to report adversely upon any nomination, the member who shall have made it shall be informed of the intention so to report, in order that he may have an opportunity to withdraw the name. Upon such report active members may be admitted, if they obtain a majority of votes of the members present and voting therefor, by acceptance in writing, and paying an admission fee of ten dollars, and maintaining their membership by the payment of an annual assessment not exceeding ten dollars.* Any member failing to pay two successive assessments shall cease to be a member at the end of six months from the date when such second assessment shall become due. Any member may withdraw from the Association upon payment of all arrearages, first giving notice of his intention so to do, in writing, to the Secretary, and the Board of Government may accept such resignation; and any member may be expelled for cause,

* This assessment has never exceeded five dollars for active members and ten dollars for associate members.

at any regular meeting, two-thirds of the members present voting therefor.

ASSOCIATE MEMBERS.

ARTICLE 3. Persons engaged in the manufacture of cotton or cotton fabrics, or the manufacture of textile machinery, or industries kindred to the cotton manufacture, may become associate members of the Association. The methods of application, nomination, election and withdrawal from the Association being under the same conditions as those provided for active members in Article 2, excepting that this class of membership does not carry with it the privilege of voting or speaking, except by permission from the Board of Government or a vote of the Association to allow permission.

The initiation fee for associate members shall be twenty-five dollars, and the annual assessment shall be double the sum annually voted for active members.

Associate members may be expelled by a majority vote of the Board of Government.

HONORARY MEMBERS.

ARTICLE 4. Honorary members may be elected, when recommended by the Board of Government, at any regular meeting of the Association, who shall be enrolled as such, and shall be entitled to attend the meetings of the Association and participate in its proceedings, without the right to vote. They shall not be subject to payment of admission fees or assessments. No person actively engaged in cotton manufacture shall be eligible to honorary membership.

ARTICLE 5. It shall be the duty of all members of the Association to make returns to the Secretary of such statistics as may be called for by him, under the direction of any committee duly appointed for the collection of statistics, when not incompatible with private interests.

OFFICERS.

ARTICLE 6. The officers of this Association shall be a President, two Vice-Presidents, six Directors, a Treasurer, Secretary, and Auditor of Accounts.

ELECTION OF OFFICERS.

ARTICLE 7. At each annual meeting there shall be chosen by ballot a President, two Vice-Presidents and two Directors; the President and Vice-Presidents to serve one year, and the two Directors shall be chosen for terms of three years.

DUTIES OF OFFICERS.

ARTICLE 8. The President, or in his absence the senior Vice-President present, shall preside at all meetings of the Association and of the Board of Government. All officers shall hold their respective offices until their successors shall be chosen and accept their positions.

ARTICLE 9. The President, Vice-Presidents and Directors shall constitute a Board of Government, and have under their care and direction all matters pertaining to the management of the Association; and five of their number shall constitute a quorum for the transaction of business. Meetings of the board may be called by the President, at such time and place as he may deem expedient, giving each member a written or printed notice of the same at least five days before the day of meeting. At their first meeting the board shall elect a Treasurer, Secretary, and Auditor of Accounts for the year ensuing, and fix the amount of compensation of the Secretary. All vacancies in their board occasioned by death or resignation shall be filled by the board; and the persons so elected shall hold their offices until the next annual meeting. The board may, from time to time, as they shall deem expedient, appoint committees, from among their own board or from the members at large, to collect statistical information, examine new inventions or processes in manufacturing goods, as also to prepare essays on subjects of interest to the Association.

ARTICLE 10. The Treasurer shall keep a book in which all receipts and payments of money shall be entered, collect all moneys due the Association, and disburse the same upon the written order of the Board of Government. At the annual meeting in each year he shall make an exhibit of his accounts, or oftener if the Board of Government require it. He shall notify the members of assessments voted, and cause them to be collected in a reasonable time.

ARTICLE 11. The Secretary shall attend all meetings of the Association and of the Board of Government, and keep accurate records of

their doings. In the absence of the Secretary at any meeting, a Secretary *pro tem.* may be appointed by the presiding officer, who shall be sworn to do all things, while in office, required of the Secretary.

ARTICLE 12. The Auditor shall examine the accounts of the Treasurer annually, and report at each meeting the state of the finances.

MEETINGS.

ARTICLE 13. The annual meeting of the members of the Association shall be held on the last Wednesday of April, or at such other time, and at such hour and place as the Board of Government may appoint. There shall also be a semi-annual meeting of the Association on the last Wednesday of October, in each and every year, or at such other time, and at such place and hour as the Board of Government may appoint.

Special meetings may be called by the Board of Government whenever they deem it expedient, or upon the written application of any ten members, made to the Secretary.

ARTICLE 14. All meetings of the members of the Association shall be in pursuance of a written or printed notice, addressed to each member, with the name of the President or Secretary attached thereto, and deposited in the Post Office ten days at least before the day of meeting, specifying the time and place of meeting; and at all such meetings fifteen members shall constitute a quorum for the transaction of business.

ARTICLE 15. Amendments to the By-Laws may be made at any stated meeting of the Association by a two-thirds vote; *provided*, notice of such proposed amendment be given in writing at a previous meeting, and also notice be given to each member by the Secretary, of the pendency of such amendment, ten days at least before any such meeting.

BOARD OF GOVERNMENT.

1902.

PRESIDENT.

CHARLES H. FISH, ... DOVER, N. H.

VICE-PRESIDENTS.

HERBERT E. WALMSLEY, . . . NEW BEDFORD, MASS.
ALFRED E. ADAMS, ... WHITINSVILLE, MASS.

DIRECTORS.

WILLIAM D. HARTSHORNE, . . LAWRENCE, MASS.
JAMES R. MacCOLL, ... PAWTUCKET, R. I.
J. R. MONTGOMERY, ... WINDSOR LOCKS, CONN.
WILLIAM D. PENNELL, ... LEWISTON, ME.
W. B. SMITH WHALEY, ... COLUMBIA, S. C.
GEORGE F. WHITTEN, . . . MANCHESTER, N. H.

AUDITOR.

C. E. ROBERTS, ... BOSTON, MASS.

SECRETARY AND TREASURER.

C. J. H. WOODBURY, P. O. Box 3672, BOSTON, MASS.

OFFICE OF THE ASSOCIATION:

ROOM 57, INTERNATIONAL TRUST BUILDING, 45 MILK STREET, CORNER OF DEVONSHIRE STREET, BOSTON, MASS.

OFFICERS OF THE ASSOCIATION,

FROM THE FIRST ORGANIZATION.

PRESIDENTS.

Ezekiel A. Straw,	1865–78	Edw. W. Thomas,	1894–95
Amos D. Lockwood,	1878–80	A. M. Goodale,	1895–96
John Kilburn,	1880–83	Arthur H. Lowe,	1896–97
William C. Lovering,	1883–85	Russell W. Eaton,	1897–98
Richard Garsed,	1885–86	Stephen A. Knight,	1898–99
J. S. Ludlam,	1886–88	Frederick E. Clarke,	1899–99
Henry F. Lippitt,	1888–89	D. M. Thompson,	1900–01
Walter E. Parker,	1889–92	CHARLES H. FISH,	1901–
Robert McArthur,	1892–94		

VICE-PRESIDENTS.

Amos D. Lockwood,	1865–77	Robert McArthur,	1889–92
William A. Burke,	1865–73	Simeon B. Chase,	1891–93
John C. Palfrey,	1873–76	E. W. Thomas,	1892–94
Edward Atkinson,	1876–78	A. M. Goodale,	1893-95
A. G. Cumnock,	1877–80	William J. Kent,	1894–97
Charles Nourse,	1878–81	Fred. C. McDuffie,	1895–00
William F. Goulding,	1880–83	Henry T. Whitin,	1897–00
Richard Garsed,	1881–85	C. H. Richardson,	1900–01
J. S. Ludlam,	1883–86	George H. Hills,	1900–02
Walter E. Parker,	1885–89	H. E. WALMSLEY,	1901–
Richard B. Borden,	1886–88	ALFRED E. ADAMS,	1902–
Arnold B. Sanford,	1888–91		

DIRECTORS.

J. S. Davis,	1865–69	F. E. Clarke,	1869–75
Charles Nourse,	1865–78	S. S. Spencer,	1887–90
Phineas Adams,	1865–74	E. W. Thomas,	1888–92
William P. Haines,	1865–69	William W. Whitin,	1888–93
Thomas J. Borden,	1865–78	Robert R. Smith,	1889–92
Daniel D. Crombie,	1865–68	Alfred M. Goodale,	1890–93
Cyrus I. Barker,	1875–80	William J. Kent,	1891–94
Hervey Kent,	1877–81	Herman F. Straw,	1891–93
David J. Johnston,	1878–82	Fred C. McDuffie,	1892–95
Walter Paine, 3d,	1878–80	George W. Bean,	1892–95
Chas. L. Lovering,	1878–83	F. M. Messenger,	1893–95
Richard Garsed,	1880–81	Arthur H. Lowe,	1894–96
William H. Jennings,	1880–83	Henry T. Whitin,	1894–97
Chas. D. McDuffie,	1881–83	Herbert L. Pratt,	1895–98
Walter E. Parker,	1881–85	Stephen A. Knight,	1895–98
John W. Danielson,	1881–85	Russell W. Eaton,	1896–97
William E. Barrows,	1882–83	Albert F. Knight,	1893–99
Rufus A. Maxfield,	1883–86	John Eccles,	1895–99
George W. Weeks,	1883–86	C. H. Richardson,	1897–00
Henry S. Howe,	1883–87	George H. Hills,	1897–00
Richard B. Borden,	1883–86	John T. Meats,	1898–01
O. S. Brown,	1885–91	Charles H. Fish,	1900–01
Henry F. Lippitt,	1885–88	Herbert E. Walmsley,	1900–01
Wilbur A. Stiles,	1886–88	Alfred E. Adams,	1899–02
Stephen N. Bourne,	1886–91	A. Tenny White,	1899–02
John Kilburn,	1870–80	GEO. F. WHITTEN,	1898–
William P. Haines,	1874–78	W. B. SMITH WHALEY,	1901–
Robert McArthur,	1886–89	Wm. D. HARTSHORNE,	1901–
A. M. Wade,	1868–69	JAMES R. MacCOLL,	1901–
D. J. Johnston,	1869–70	J. R. MONTGOMERY,	1902–
A. G. Cumnock,	1869–77	WM. D. PENNELL,	1902–

AUDITORS.

BENJAMIN SAUNDERS,	1865–71	J. HERBERT SAWYER,	1882–00
JOHN C. PALFREY,	1871–73	C. E. ROBERTS,	1900–
HENRY D. SULLIVAN,	1873–82		

SECRETARY AND TREASURER.

AMBROSE EASTMAN,	1865–94	C. J. H. WOODBURY,	1894

MEMBERS OF THE ASSOCIATION.

May. 1, 1902.

Members of the Association are respectfully requested to scrutinize the following list, and advise the Secretary, P. O. Box 3672, Boston, Mass., of change in address, or any error in regard to their names.

As a number of members rejoined the Association after severing their first membership, the date of their earliest election is given.

HONORARY MEMBERS.

GEORGE ARMS	Grand Hotel	New York City	Oct. 16, 1872.
AMBROSE EASTMAN	53 State St., Room 904,	Boston, Mass.	Sept. 27, 1894.
HENRY SMITH PRITCHETT, LL.D.,	Pres. Mass. Institute of Technology,	Boston, Mass.	Sept. 26, 1901.
SAMUEL WEBBER	Hydraulic Engineer	Charlestown, N. H.	Apr. 20, 1865.

ACTIVE MEMBERS.

Alfred E. Adams	Agt. Whitinsville Cotton Mills, Agt. Linwood Mills	Whitinsville, Mass.	Apr. 27, 1887.
John S. Adams, Jr.	Supt. Adams Bros. Mfg. Co. 120 Commercial St.,	Adams, Mass.	Apr. 29, 1896.
Joseph D. Aiken	Asst. Supt. Ponemah Mills	Taftville, Conn.	Oct. 28, 1891.
F. S. Akin	Supt. Cornell Mills	Fall River, Mass.	Sept. 27, 1894.
Charles T. Aldrich	Treas. Aldrich Mfg. Co. Box 34,	Providence, R. I.	Apr. 28, 1886.
George E. Ames	Mech. Supt. Lawrence Mfg. Co.	Lowell, Mass.	Apr. 24, 1895.
William Ames	Treas. Fletcher Manufg. Co., Box 83, 47 Charles St.,	Providence, R. I.	Apr. 30, 1879.
Charles B. Amory	Treas. Hamilton Manufg. Co. 70 Kilby St.,	Boston, Mass.	Apr. 25, 1894.
Frederic Amory	Treas. Nashua Mfg. Co. and Jackson Mfg. Co. Room 51, Simmons B'l'd., 40 Water St.,	Boston, Mass.	Apr. 27, 1899.

Thomas Armstrong	Supt. No. Pownal Mfg. Co.	No. Pownal, Vt.	Oct. 28, 1897.
Abel T. Atherton	Machine Maker	Bay Side, R. I.	Oct. 16, 1872.
Edward Atkinson	Prest. Boston Mfrs. Mu. Fire Ins. Co.	31 Milk St., Boston, Mass.	Apr. 19, 1871.
E. W. Atkinson	Stoddard, Haserick, Richards & Co.	152 Congress St., Boston, Mass.	Oct. 27, 1886.
H. C. Atwood	Treas. Williamsville Manufg. Co.	Providence, R. I.	Apr. 29, 1885.
James A. Atwood	Agt. Wauregan Co. and Quinebaug Co.	Wauregan, Conn.	Oct. 28, 1891.
John Walter Atwood	Supt. Wauregan Co.	Wauregan, Conn.	Oct. 25, 1895.
W. E. Atwood	Secy. and Asst. Treas. Williamsville Manufg. Co.	Killingly, Conn.	Sept. 27, 1894.
George A. Ayer	Supt. West Boylston Co.	Easthampton, Mass.	Apr. 24, 1895.
Nathaniel F. Ayer	Asst. Mgr. Farwell Bleachery	56 Summer St., Boston, Mass.	Apr. 25, 1901.
Henry A. Bailey	Agt. Chicopee Manufg. Co.	Chicopee Falls, Mass.	Oct. 25, 1893.
Dickerson G. Baker	Mech. Eng., American Thread Co.	P. O. Box B, Willimantic, Conn.	Oct. 18, 1900
Edwin H. Baker	Bliss, Fabyan & Co., Box 2899	117 Duane St., New York City, N. Y.	Apr. 24, 1878.
Edward R. Ballou	Treas. Ballou Yarn Co.,	189 Charles St., Providence, R. I.	Apr. 25, 1894
William P. Bancroft	Vice-Pres. Joseph Bancroft & Sons Co.	Wilmington, Del.	Oct. 31, 1883.
Louis B. Barker	Agt. United States Cotton Co.	Central Falls, R. I.	Apr. 27, 1899.
Lewis E. Barnes	Agt. Pemberton Co. & Methuen Co.,	Methuen, Mass.	Oct. 25, 1895.
William A. Barrell	Agt. Lawrence Duck Co.	Lawrence, Mass.	Apr. 30, 1884.
Thomas Barrett, Jr.	Pres. Langley & Aiken Mills	Augusta, Ga.	Apr. 26, 1900.
Edwin N. Bartlett	Supt. Sigourney and Rockdale Mills,	North Oxford, Mass.	Apr. 29, 1891.
Daniel Moore Bates	Asst. Supt. Joseph Bancroft & Sons Co.,	Rockford, Wilmington, Del.	Apr. 27, 1898.
Joseph P. Battles	Crompton & Knowles Loom Works,	Worcester, Mass.	Oct. 25, 1895.
Edward C. Beach	Supt. Gate City Cotton Mills	East Point, Georgia	Oct. 5, 1899.
C. Enos Bean	Supt. Millville Mfg. Co.	Millville, N. J.	Apr. 24, 1902.
George W. Bean	Agt. Androscoggin Mills	Lewiston, Me.	Apr. 17, 1872.
Robert Beatty	Robert Beatty & Co.	Coral and Adams Sts., Philadelphia, Pa.	Oct. 28, 1897.
Truman Beckwith	Treas. Dyerville Manufg. Co. Box 171,	Providence, R. I.	Apr. 27, 1892.
John W. Bell	Asst. Treas. Smith & Dove Manufg. Co.	Andover Mass.	Oct. 28, 1897.
A. C. Bent	Agt. Safety Seamless Pocket Co.	Taunton, Mass.	Oct. 28, 1897.
William H. Bilbrough	Mgr. Elmira Knitting Mills and Mgr. Conewawah Spinning Co.,	Elmira, N. Y.	Apr. 24, 1902.
W. N. Blackstone	Treas. Attawaugan Co. / Treas Totokett Mills Co	Norwich, Conn.	Apr. 29, 1896.

Wm. Washington Blades	Gen. Supt. Lorraine Mfg. Co.	135 Mineral Spring Ave., Pawtucket, R. I.	Oct. 25, 1893.
T. Ashby Blythe	Proprietor Ashby Cotton Mills	114 Chestnut St., Philadelphia, Pa.	Oct. 28, 1897.
John P. Bodge	Treas. Arkwright Mills	Fall River, Mass.	Oct. 28, 1897.
Jefferson Borden, Jr.	Supt. Fall River Bleachery Co.	Fall River, Mass.	Apr. 21, 1869.
Nathaniel B. Borden	Treas. Barnard Manufg. Co.	Fall River, Mass.	Oct. 15, 1873.
Richard B. Borden	Treas. Richard Borden Mfg. Co. Treas. Troy C. & W. Mfg. Co.	Fall River, Mass.	July 19, 1865.
Thomas J. Borden	326 North Main St.	Box 118, Fall River, Mass.	Apr. 20, 1865.
E. S. Boss	Agt. Willimantic Linen Co.	Willimantic, Conn.	Oct. 29, 1879.
Henry Deane Bourne	Treas. Hooksett Mfg. Co., 1741 Elm St.	Manchester, N. H.	Oct. 18, 1900.
Stephen N. Bourne	Agt. Dundee Mills	Hooksett, N. H.	Oct. 21, 1868.
Frank A. Bowen	Supt. Appleton Co.	Lowell, Mass.	Apr. 28, 1897.
Arthur F. Brackett	Supt. Royal Arctic & Valley Queen Mills,	Riverpoint, R. I.	Oct. 25, 1895.
A. W. Brainerd	Gen. Mgr. Millville Mfg. Co. and May's Landing Water Power Co.	Millville, N. J.	Apr. 27, 1898.
Ernest Bridge	Supt. Jas. Chadwick & Bro. Ltd.	Jersey City, N. J.	Apr. 24, 1895.
George T. Briggs,	Vice-Pres. and Gen. Mgr. The Briggs Mfg. Co.	Voluntown, Conn.,	Apr. 24, 1902.
Christopher P. Brooks	Managing Director New Bedford Textile School	New Bedford, Mass.	Apr. 28, 1897.
Henry R. Brown	Supt. Phenix Mill	Box 56, Phenix, R. I.	Apr. 28, 1897.
Isaac A. Brown	Treas. Narragansett Mills	Box 324, Fall River, Mass.	Sept. 29, 1898.
James W. Brown		P. O. Box 312, Ipswich, Mass.	Oct. 25, 1895.
O. S. Brown	Agt. Salmon Falls Manufg. Co.	Salmon Falls, N. H.	Apr. 21, 1875.
Thomas J. Brown	George Brown's Sons	Mt. Joy, Penn.	Oct. 28, 1897.
E. C. Bucklin	Treas. Interlaken Mills	Butler's Exchange, Box 289, Providence, R. I.	Apr. 25, 1883.
Robert Burgess	Treas. Slater Cotton Co.	Pawtucket, R. I.	Apr. 27, 1892.
Edward N. Burke	Lowell Machine Shop	Lowell, Mass.	Apr. 28, 1880.
Alfred H. Burnham	Mgr. Glasgow Mills, Station Kensington	Huntington and Jasper Sts., Philadelphia, Pa.	Apr. 26, 1900.
Hervey Burnham	Supt. Beaver Mills and Eclipse Mill	270 East Main St., North Adams, Mass.	Apr. 27, 1899.
W. R. Burnham		Norwich, Conn.	Apr. 29, 1885.

William D. Cadwell	Agt. Nashua Mfg. Co., 67 Concord St.,	Nashua, N. H.	Apr. 19, 1871.
William H. Cadwell	Agt. Jackson Company	Nashua, N. H.	Apr. 26, 1900.
John P. Campbell	Supt. New York Mills,	New York Mills, Oneida Co., N. Y.,	Sept. 22, 1896.
Byron F. Card		New Bedford, Mass.	Apr. 25, 1888.
Samuel A. Carter	Pres. Gate City Cotton Mills	Atlanta, Ga.	Sept. 26, 1901.
George A. Chace	Treas. Bourne Mills	Fall River, Mass.	Apr. 25, 1877.
John W. Chafee	Pres. and Treas. The Sibley Mfg. Co.	Augusta, Ga.	Oct. 18, 1900.

Simeon B. Chase	Treas. King Philip Mills	Fall River, Mass.	Apr. 21, 1875.
Clarence N. Childs	Asst. Supt. Hamilton Manufg. Co. 43 Pine St.	Lowell, Mass.	Apr. 24, 1895.
Elmer G. Childs	Agt. Boston Duck Co.	Bondsville, Mass.	Oct. 26, 1892.
Jno. H. C. Church	Asst. Treas and Sec. Monument Mills,	Gt. Barrington, Mass.	Apr. 28, 1897.
Ernest E. Clark	Mech. Supt. Montreal Cotton Co.	Valleyfield, P. Q.	Apr. 29, 1896.
George A. Clark	Supt. Manchester Mills	Manchester, N. H.	Oct. 25, 1882.
E. N. Clemence	Sec. and Treas. Eagle & Phenix Mills	Columbus, Ga.	Apr. 28, 1897.
W. H. Cloher, Jr.	Treas. and Agt. Utica Cotton Co.	Capron, Oneida Co., N. Y.,	Sept. 22, 1896.
Josiah G. Coburn	99 Washington St.,	Newton, Mass.	Apr. 20, 1865.
Charles H. Collins	Supt. Berkeley Co.	Ashton, R. I.	Apr. 26, 1900.
John A. Collins	Supt. American Linen Co. 73 Cottage St.,	Fall River, Mass.	Oct. 31, 1883.
B. B. Comer	Pres. and Treas. Avondale Cotton Mills	Birmingham, Ala.	Apr. 26, 1900.
Frank B. Comins	Treas. American Moistening Co. 150 Devonshire St., Room 67,	Boston, Mass.	Oct. 28, 1891.
Caesar Cone	Pres. Proximity Mfg. Co.	Greensboro, N. C.	Apr. 26, 1900.
John J. Connell	Agt. Tremont & Suffolk Mills	Lowell, Mass.	Apr. 27, 1892.
Sidney Coolidge	Treas. Stark Mills, 50 State St., Room 17	Boston, Mass.	Sept. 26, 1901.
Peter H. Corr	Treas. Greenwich Bleachery	Taunton, Mass.	Apr. 24, 1895.
Frank H. Cotton	Mgr. Hope Mills Mfg. Co.	Hope Mills, N. C.	Apr. 27, 1899.
Lyman M. Cousens,	Pres. Dana Warp Mills	Portland, Me.	Apr. 24, 1902.
Alphonse S. Covel	Treas. Tremont and Suffolk Mills, P. O. Box 1716, 70 Kilby St.,	Boston, Mass.	Oct. 31, 1877.
Richard Cowell	Supt. Boott Cotton Mills, 25 Read St.,	Lowell, Mass.	Apr. 24, 1902.
William W. Crapo	Pres. Wamsutta Mills	New Bedford, Mass.	Sept. 29, 1898.
William J. Cray	Supt. Aldrich Mfg. Co.	Moosup, Conn.	Apr. 25, 1901.
P. T. Creed	Agt. Hopewell Mills	Box 356, Taunton, Mass.	Sept. 22, 1896.
John B. Cudlip	Mgr. Cornwall & York Cotton Mills Co.	St. John, N. B.	Apr. 28, 1897.
H. H. Culver	Supt. Elizabeth Poole Mills 39 Ashland St.,	Taunton, Mass.	Apr. 28, 1897.
Henry S. Culver	Supt. Westville Cotton Mills	Taunton, Mass.	Apr. 28, 1897.
A. G. Cumnock	Treas. Appleton Co.	Box 2284, Lowell, Mass.	July 19, 1865.
Andrew J. Currier	Supt. Cohannet & Nemasket Mills	Taunton, Mass.	Apr. 25, 1888.
T. B. Dallas	Treas. Dallas Manufg. Co.	Box 386, Nashville, Tenn.	Oct. 25, 1895.
Philip Dana	Supt. Dana Warp Mills	Westbrook, Me.	Sept. 29, 1898.
Woodbury K. Dana	Treas. Dana Warp Mills	Westbrook, Me.	Apr. 25, 1888.
Albert W. Danforth	Mech. Eng. Shanghai Cot. Cloth Mills, Shanghai, China 881 Bridge St.,	Lowell, Mass.	Apr. 27, 1881.
A. Lockwood Danielson	Asst. Treas. Quinebaug Co.,	Box 900, Providence, R. I.	Sept. 27, 1894.
J. DeForest Danielson	Asst. Treas. Lockwood Co. & Lewiston Bleachery & Dye Works	Providence, R. I.	Sept. 27, 1894.

John W. Danielson	Treas. Lockwood Co. and Ponemah Mills	Box 900, Providence, R. I.	July 15, 1868.
Bradford D. Davol	Pres. Barnard Mfg. Co.	P. O. Box 418, Fall River, Mass.	Apr. 25, 1877.
Albert Deabill	Supt. Lowell Hosiery Co., Mt. Vernon St.	Lowell, Mass.	Apr. 25, 1901.
Augustus De Cort	Treas. Beacon Mfg. Co., P. O. Box 2815	Boston, Mass.	Apr. 26, 1900.
George DeForest	Treas. Utica Steam Cotton Mills	Utica, New York	Oct. 28, 1897.
William P. Dempsey	Treas. Dempsey Bleachery and Dye Works, Pawtucket, R. I.		Apr. 28, 1886.
Charles W. Dennett	Vice Pres. and Agt. Johnson-Dunbar Mills Co.	North Adams, Mass.	Oct. 29, 1890.
Edward P. Dennis	Lowell Machine Shop	Lowell, Mass.	Apr. 25, 1888.
Charles A. Denny	Pres. American Card Clothing Co.	Leicester, Mass.	Apr. 25, 1888.
P. Y. DeNormandie	Treas. Pepperell Mfg. Co.	30 Kilby St., Boston, Mass.	Apr. 29, 1896.
Charles Owen Dexter	Mgr. Canadian Colored Cotton Mills Co. Ltd.	Hamilton, Ont., Can.	Apr. 24, 1895.
Henry C. Dexter,	Agt. and Sec. Greene & Daniels Mfg. Co.	Pawtucket, R. I.	Apr. 25, 1901.
Lewis Dexter, Jr.	Mgr. The Canadian Colored Cotton Mills Co., Ltd.	Milltown, N. B.	Apr. 27, 1899.
F. Dilling	Pres. Dilling Cotton Mills	Kings Mountain, N. C.	Oct. 25, 1895.
Albert W. Dimick	Supt. Fisher Mfg. Co.	Fisherville, Mass.	Apr. 25, 1894.
Bradford C. Divine	Supt. Utica Willowvale Bleaching Co.	Chadwicks, N. Y.	Apr. 27, 1899.
Robert Dow,	Partner in Solway Mills,	Westerly, R. I.	April 25, 1901.
Eben S. Draper	Agt. Draper Co.	Hopedale, Mass.	Oct. 31, 1888.
George A. Draper	Treas. Draper Co.	Hopedale, Mass.	Oct. 31, 1888.
George Otis Draper	Sec'y Draper Co.	Hopedale, Mass.	Apr. 24, 1895.
William F. Draper	Pres. Draper Co.	Hopedale, Mass.	July 17, 1867.
William F. Draper, Jr.	Draper Co.	Hopedale, Mass.	Oct. 29, 1890.
Harry K. Drew	Supt. Clinton Mfg. Co., 93 Clinton St.,	Woonsocket, R. I.	Apr. 24, 1902.
Frederic C. Dumaine,	Treas. Amory Mfg. Co., Box 2879	64 Ames Building, Boston, Mass.	April 25, 1901.
T. C. Duncan	Pres. and Treas. Union Cotton Mills	Union, S. C.	Apr. 26, 1900.
Joseph M. Dunham		43 Edwards St., Springfield, Mass.	Oct. 26, 1892.
Frank J. Dutcher	Pres. Shaw Stocking Co.	Hopedale, Mass.	Apr. 24, 1902.
Frank H. Dwelly	Treas. Tecumseh Mills	Fall River, Mass.	Apr. 27, 1899.
David H. Dyer	D. H. Dyer & Son, Mill Engineers, P. O. Box 582,	6, 7 and 8 Pocassett Bank Building, Fall River, Mass.	Oct. 18, 1871.
Benjamin M. Earle	Prop. Merchants Dye Works	Walnut Hill, Mass.	Sept. 26, 1901.
Wm. Ambrose Eastman,	Treas. Lowell Hosiery Co.	Lowell, Mass.	Apr. 24, 1878.
Russell W. Eaton	Agt. Cabot Manufg. Co.	Brunswick, Me.	Oct. 27, 1887.
John Eccles	Agt. Ponemah Mills	Taftville, Conn.	Apr. 27, 1892.
Lawrence V. Elder	Man. Dir. Galveston City Cotton Mills	212 Tremont St., Galveston, Texas	Oct. 27, 1886.
Oscar Elsas	Vice-Pres. Fulton Bag & Cotton Mills,	P. O. Box 773, Atlanta, Ga.	Apr. 28, 1897.

Frederick W. Ely	Agt. Columbian Manufg. Co.	Greenville, N. H.	Apr. 25, 1888.
H. B. Estes	Agt. Continental Mills	Lewiston, Me.	Apr. 26, 1893.
William Evans	Treas. Wampanoag Mills	Fall River, Mass.	Apr. 29, 1896.
D. A. Everly	Cotton Mfr.	Pawtucket, R. I.	Apr. 24, 1902.
Charles F. Farrar	22 Coggeshall St.,	Fall River, Mass.	Oct. 28, 1897.
George E. Farrell	Treas. Utica Spinning Co.	Utica, N. Y.	Oct. 18, 1900.
James T. Ferguson	Supt. Warwick Mills	Centreville, R. I.	Oct. 5, 1899.
Frank S. Field	Supt. & Agt. Massaemit Yarn Mills	Shattuckville, Mass.	Oct. 25, 1895.
William Firth	Pres. American Moistening Co. & Wm. Firth Co. P. O. Box 1460, 150 Devonshire St., Room 67,	Boston, Mass.	Apr. 25, 1888.
Charles H. Fish	Agt. Cocheco Manufg. Co.	Dover, N. H.	Apr. 27, 1887.
Charles W. Fisher,	Asst. Supt. Fisher Mfg. Co.	Fisherville, Mass.	Apr. 25, 1901.
Henry E. Fisher	Vice-Pres. & Agt. Atlanta Cotton Mills	Atlanta, Ga.	Oct. 25, 1895.
Herbert Fisher		Taunton, Mass.	Oct. 29, 1879.
William B. Fittz		Easthampton, Mass.	Oct. 26, 1892.
Frederick A. Flather	Supt. McCormick Harvesting Machine Co.	Chicago, Ill.	Apr. 29, 1891.
F. C. Fletcher	Vice Pres. Lawton Spinning Co. 621 Banigan Building,	Providence, R. I.	Oct. 18, 1900.
M. F. Foster		Milford, N. H.	Apr. 17, 1872.
Philip H. Fowler	417 Monmouth St.,	Gloucester, N. J.	Nov. 30, 1881.
Edward W. France	Dir. of Philadelphia Textile School, 320 So. Broad St.,	Philadelphia, Pa.	Sept. 22, 1896.
Arthur C. Freeman	Agt. Rusden Machine Co. 39-41 Cortlandt St.,	New York, N. Y.	Apr. 27, 1899.
John W. Fries	Managing Partner, F. & H. Fries,	Winston-Salem, N. C.	Oct. 18, 1900.
C. H. Frisbie	Agt. Attawaugan Co.	Norwich, Conn.	Oct. 29, 1890.
W. T. Galey	Pres. Aberfoyle Manufg. Co.	Chester, Pa.	Apr. 28, 1897.
William Gammell	Agt. Berkeley Co.	Providence, R. I.	Oct. 28, 1885.
James G. Garland		Saco, Me.	Oct. 29, 1879.
Edward T. Garsed	Treas. Hucomuga Mills	Greensboro, N. C.	Apr. 27, 1898.
Joshua Garsed	Wingohocking Mills and National Spinning Co., Frankford	Philadelphia, Pa.	Oct. 28, 1897.
James A. Gary	Alberton Mills	108 German St., Baltimore, Md.	Apr. 25, 1883.
James Gee	Supt. Interlaken Dye Works	Fiskville, R. I.	Apr. 27, 1898.
Charles E. Getchell	Supt. Waltham Bleachery and Dye Works P. O. Box 62, 35 Willow St.,	Waltham, Mass.	Oct. 30, 1889.
William C. Godfrey	Agt. Indian Orchard Co.	Indian Orchard, Mass.	Oct. 29, 1890.
Otto Goetze,	Partner and Gen. Mgr. Glasgow Mills	Philadelphia, Pa.	Apr. 24, 1902.
Alfred M. Goodale	Treas. Boston Manufg. Co. 50 State St.,	Boston, Mass.	Apr. 25, 1883.
Louis B. Goodall	Treas. Goodall Worsted Co.	Sanford, Me.	Oct. 5, 1899.
Frederick B. Gordon	Pres. Columbus Mfg Co.	Columbus, Ga.	Apr. 26, 1900.

Charles H. Gorton	Supt. Columbus Mfg. Co.	Columbus, Ga.	Apr. 25, 1894.
Marcellus Gould	Pres. and Mgr. N. H. Spinning Mills	Penacook, N. H.	Sept. 22, 1896.
George P. Grant, Jr.	Treas. Grant Yarn Co.	Fitchburg, Mass.	Sept. 27, 1894.
D. W. Gray	Supt. Skenandoa Cotton Co.	Utica, N. Y.	Oct. 26, 1892.
R. A. Gray	Supt. Rodman Manufg. Co.	Allenton, R. I.	Apr. 24, 1895.
Joseph Warren Greene	Supt. Hamilton Web Co.	Hamilton, R. I.	Apr. 29, 1896.
William C. Greene	Treas. Peace Dale Manufg. Co.	Peace Dale, R. I.	Oct. 27, 1886.
William H. Greene,	Treas. Greene & Daniels Mfg. Co.,	Pawtucket, R. I.	Apr. 25, 1901.
John T. Greenwood	R. Greenwood & Bault	4720 Leiper St., Frankford, Philadelphia, Pa.	Apr. 26, 1900.
S. Greenwood	Mgr. Canadian Col'd Cot. Mills Co. Ltd.	Cornwall, Ontario	Oct. 5, 1899.
John Gregson	Agt. Fiskdale Mills	Fiskdale, Mass.	Apr 24, 1895.
Maxwell Grierson	Gen. Mgr. Jas. Chadwick & Bro., Ltd.,	Jersey City, N. J.	Apr. 27, 1898.
Frederick Grinnell	Pres. Gen. Fire Extinguisher Co.	New Bedford, Mass.	Apr. 24, 1878.
David Grove	Supt. U. S. Cotton Co.	Central Falls, R. I.	Apr. 27, 1898.
Henry S. Grove	Pres. Argo Mills Co.,	318 Marine and Merchant Bldg., Philadelphia, Pa.	Apr. 27, 1898.
Arthur H. Gulliver	Agt. Boston Mfg. Co.	Waltham, Mass.	Apr. 24, 1889.
B. F. Guy	Supt. Pelzer Manufg. Co.	Box 125, Pelzer, S. C.	Apr. 24, 1895.
William J. Hadfield	Newburgh Steam Mills,	236 Montgomery St., Newburgh, N. Y.	Apr. 27, 1899.
Frank J. Hale	Gen. Agt. Saco and Pettee Machine Shops	Newton Upper Falls, Mass.	Apr. 27, 1892.
Walter B. Hall	Supt. Pontiac Mill, B. B. & R. Knight,	Pontiac, R. I.	Apr. 25, 1901.
William E. Hall	Treas. Shaw Stocking Co.	Lowell, Mass.	Apr. 27, 1892.
Z. D. Hall	Supt. Berkshire Cotton Mfg. Co.	70 Orchard St., P. O. Box 963, Adams, Mass.	Oct. 29, 1879.
William Halliwell,	Agt. Providence and Woonsocket Mills of the Lawton Spinning Co.,	Woonsocket, R. I.	Sept. 26, 1901.
John H. Hambly	Treas. Quidnick Manufg. Co.	49 Westminster St, Providence, R. I.	Apr. 24, 1895.
Arthur M. Hamilton	Supt. Hargraves and Parker Mills	362 Linden St., Fall River, Mass.	Apr. 28, 1897.
John F. Hamlet	Manufacturer	P. O. Box 160, Fall River, Mass.	Oct. 31, 1888.
Joseph O. Hannum	Agt. Indian Head Mills of Alabama	Cordova, Ala.	Apr. 30, 1890.
A. G. Harris,	Supt. W. H. Draper & Son,	10 Third St., Upper Troy, N. Y.	Sept. 26, 1901.
Henry F. Harris	Treas. West Boylston Manufg. Co.	340 Main St., Worcester, Mass.	Apr. 30, 1890.
John J. Hart	Pres. and Gen. Mgr. Charlton Manufg. Co.	P. O. Box 94, Pawtucket, R. I.	Apr. 24, 1895.
William D. Hartshorne	Agt. Arlington Mills	Lawrence, Mass.	Apr. 27, 1899.
Samuel E. Hathaway	Supt. Fall River Iron Works Co.	Fall River, Mass.	Sept. 27, 1894.
William Hathaway	Supt. Barnard Manufg. Co.	Fall River, Mass.	Apr. 25, 1894.

William B. Hawes . . Yarn Broker . . . 108 Bedford St., ... P. O. Box 733, Fall River, Mass. Apr. 24, 1895.
Alfred Hawkesworth . Supt. Merchants' Cotton Co. . . . . Montreal, P. Q. . . . Apr. 26, 1893.
Fred Hawkesworth . . Asst. Supt. Merchants' Cotton Co. . Montreal, P. Q. . . . Sept. 22, 1896.
William Hayes . . . . Agt. Barker Mill . . . . . Auburn, Me. . . . . Apr. 30, 1879.
W. G. Henderson . . . Agt. Shetucket Co. . . . . Norwich, Conn. . . . Apr. 29, 1896.
A. E. Henry, ... Mfr. Partner in Solway Mills, . . . Westerly, R. I. . . . Apr. 25, 1901.
T. I. Hickman, ... Pres. and Treas. Graniteville Mfg. Co. . . . . Leonard Bldg., Augusta, Ga. . . . . Apr. 25, 1901.
Ernest L. Hill . . . . Vice-Pres. Renfrew Mfg. Co. . . . . 320 Broadway, New York City . . . Apr. 24, 1902.
William H. Hill . . . Pres. Windsor Co. and Pres. Renfrew Mfg. Co. . . . . 40 Water St., Boston, Mass. . . . Apr. 24, 1902.
William R. Hill . . . Treas. Glasgow Manufg. Co. . . . . South Hadley Falls, Mass. Oct. 25, 1893.
George H. Hills . . . Treas. Davol Mills & Stevens Mfg. Co. . Fall River. Mass. . Oct. 25, 1895.
Charles H. Hobbs . . Agt. Thorndike Co. . . . . Thorndike, Mass. . . . Apr. 28, 1886.
Franklin W. Hobbs . . Treas. Arlington Mills . . . . . P. O. Box 5317, 78 Chauncy St., Boston, Mass. . . . Apr. 27, 1899.
William Henry Hobbs . Asst. Supt. Johnson & Johnson Co., New Brunswick, N. J. Apr. 24, 1902.
Louis L. Hohn . . . . . 122 High St., Westerly, R. I. . . . Apr. 28, 1897.
Charles M. Holmes . . Supt. Natick Mills . . . . . Natick, R. I., . . . Apr. 27, 1899.
Gideon F. Holmes . . Treas. and Gen. Mgr. Plymouth Cor- . . . . . dage Co. . . . . No. Plymouth, Mass. . Oct. 30, 1889.
George W. Holt . . . Agt. Monohansett Manufg. Co. . . Putnam, Conn. . . . Oct. 29, 1879.
Walter L. Holt . . . . Pres. Holt-Morgan Mills . . . . . Fayetteville, N. C. . . Oct. 18, 1900.
William P. Holt . . . Supt. Barnaby Mills . . . . . Fall River, Mass. . . Oct. 25, 1893.
Edward W. Houghton . Supt. Globe Mill . . . . . Woonsocket, R. I. . . Apr. 24, 1902.
Henry S. Houghton, Jr. Supt. Paul Whitin Manufg. Co. . . Northbridge, Mass. . Apr. 24, 1895.
W. C. Houston . . . . Pres. Hope Mills Manufg. Co. . . . . 333 Drexel Building, Philadelphia, Pa. . . Apr. 28, 1897.
Elisha H. Howard . . Cotton Goods Broker, 20 Market Sq., Providence, R. I. . . Apr. 25, 1883.
Henry S. Howe . . . . Dry Goods Commission, 68 Chauncy St., Boston, Mass. . Oct. 31, 1877.
Albert C. Hoy . . . . Asst. Supt. Hamlet Mills . . . . . Woonsocket, R. I. . . Apr. 27, 1898.
Charles W. Hubbard . Treas. and Sec. Ludlow Mfg. Associates . . . . . 133 Essex St., Boston, Mass. . . . Apr. 25, 1901.
W. S. Hume . . . . . Supt. Dominion Cotton Mills, Ltd. . . . . 176 Notre Dame St., Hochelaga, P. Q., Can. Oct. 29, 1890.
Otis L. Humphrey, . . Cotton Dept. Lowell Textile School, Lowell, Mass. . . . Apr. 25, 1901.
Arthur W. Hunking . . . . . 374 Stevens St., Lowell, Mass. . . . Apr. 24, 1895.
George A. Hurd, . . . Supt. Cocheco Mfg. Co. . . . . Dover, N. H. . . . . Apr. 25, 1901.

D. Edwin Irving . . . Treas. The Irving & Leiper Mfg. Co., Chester, Pa. . . . . Oct. 28, 1897.

J. E. Jenckes . . . . . Treas. E. Jenckes Manufg. Co. . . Pawtucket, R. I. . . Apr. 24, 1895.
Edward B. Jennings . . Treas. Samoset Co. . . . . Valley Falls, R. I. . . Sept. 29, 1898.

David L. Jewell . . . Agt. China, Webster & Pembroke Mills . Suncook, N. H. . Apr. 20, 1865.
David S. Johnston . . Treas. Cohoes Iron Foundry & Mach. Co., Cohoes, N. Y. . Oct. 28, 1891.
W. T. Jordan . . . . Mgr. Mountain Island Mfg. Co. . . Mountain Island, N. C. Oct. 25, 1895.

Frank E. Kaley . . . . Treas. Morse & Kaley Mfg. Co. . . Milford, N. H. . . . Oct. 25, 1895.
W. E. Keach . . . . . Supt. Grant Yarn Co. . 123 Myrtle Ave., Fitchburg, Mass. Oct. 26, 1892.
Roland R. Kelly . . . Supt. Williamstown Manufg. Co. . Williamstown Sta., Mass. Nov. 30, 1881.
George E. Kent . . . . Treas. Exeter Manufg. Co. . . . . Exeter, N. H. . . . Oct. 31, 1888.
Hervey Kent . . . . . Pres. Exeter Manufg. Co. . . . . Exeter, N. H. . . . Apr. 20, 1865.
Nathaniel B. Kerr . . . Treas. Butler Mill . . . . . New Bedford, Mass. . Oct. 26, 1892.
John Kilburn . . . . . Belmont, Mass. . . . Apr. 20, 1865.
Harry W. Kimball . . Supt. Fulton Bag & Cotton Mills . Atlanta, Ga. . . . . Oct. 25, 1895.
William N. Kimball . . Supt. Social and Nourse Mills, Manville Co. . . . . Woonsocket, R. I. . . Apr. 24, 1902.
Emil Kipper . . . . . Treas. Renfrew Mfg. Co. and Windsor Print Works . . . . . Adams, Mass. . . . . Apr. 24, 1902.
Albert F. Knight . . . . . Box 133, 39 Main St., Woonsocket, R. I. . . Oct. 27, 1886.
C. Prescott Knight . . B. B. & R. Knight's Mills . . . . River Point, R. I. . . Sept. 29, 1898.
Jesse A. Knight . . . . Supt. Cohannet Mills . . . . . Taunton, Mass. . . . Oct. 26, 1892.
Stephen A. Knight . . Pres. Hebron Manufg. Co., Box 820, Providence, R. I. . . Oct. 21, 1868.
Walter B. Knight . . . Reynolds Manufg. Co. . . . . Davisville, R. I. . . Apr. 24, 1889.
Webster Knight . . . B. B. & R. Knight's Mills . . . . . 3 Washington Row, Providence, R. I. . . Oct. 31, 1888.

Fred Lacey . . . . . Mgr. Montreal Cotton Co. . . . . Valleyfield, P. Q. . . Apr. 24, 1895.
Elliott Cowdin Lambert Supt. Amoskeag Manufg. Co. . . . Manchester, N. H. . Oct. 25, 1895.
William T. Lang . . . Agt. Brookside Mills . . . . . Knoxville, Tenn. . . Apr. 28, 1897.
Walter H. Langshaw . Agt. Dartmouth Manufg. Corp. . . New Bedford, Mass. . Apr. 29, 1896.
George H. Law . . . Supt. Merchants' Mfg. Co. . . . . 815 Walnut St., Fall River, Mass. . . Apr. 28, 1897.
Harold Lawton . . . . Mgr. Baltic Mills Co. . . . . Baltic, Conn. . . . . Oct. 27, 1886.
John Edward Lawton . Governing Director American Thread Co. . . . . Matlock, Derbyshire, England . Apr. 25, 1901.
Calvin H. Lee . . . . Supt. Readville Cotton Mills . . . Hyde Park, Mass. . . Apr. 24, 1902.
Evan Arthur Leigh . . Textile Machinery . . 70 Kilby St., Boston, Mass. . . . Oct. 29, 1890.
John Leiper . . . . . Supt. Fitchburg Worsted Mills, Upland Road . . . . . 171 Blossom St., Fitchburg, Mass. . . Oct. 28, 1897.
J. Colby Lewis . . . . Supt. & Mgr. Vesta Cotton Mills, . . Gainesville, Ga. . . . Oct. 26, 1892.
Charles F. Libby . . . Supt. Shaw Stocking Co. . . . . Lowell, Mass. . . . Apr. 24, 1902.
Leontine Lincoln . . . Pres. Seaconnet Mills . . . . . Fall River, Mass. . . Apr. 28, 1897.
B. F. G. Linnell . . . Commission Merchant, Yarns, Threads and Twines . . . . . P. O. Box 645, Central Falls, R. I. . . Oct. 28, 1897.
Charles Warren Lippitt, Treas. Silver Spring B. & D. Co. . . . . 7 Young Orchard Ave., Providence, R. I. . . Oct. 30, 1878.
Henry F. Lippitt . . . Agt. Social and Manville Cos. . . . Providence, R. I. . . Apr. 27, 1881.

William H. Loftus	Supt. Clark Thread Co.	Newark, N. J.	Oct. 28, 1897.
Robert W. Lord	Agt. R. W. Lord & Co.	Kennebunk, Me.	Oct. 20, 1869.
Ernest Lovering	Agt. Lyman Mills	Holyoke, Mass.	Apr. 25, 1888.
Henry M. Lovering	Agt. Whittenton Manufg. Co.	Taunton, Mass.	Oct. 27, 1880.
William C. Lovering	Pres. Whittenton Manufg. Co., 40 Water St.,	Boston, Mass.	Oct. 25, 1876.
William M. Lovering	Supt. Whittenton Manufg. Co.	Taunton, Mass.	Sept. 27, 1894.
Arthur H. Lowe	Treas. Parkhill Manufg. Co.	Fitchburg, Mass.	Oct. 30, 1889.
David Lowe	Asst. Supt. Parkhill Manufg. Co.	Fitchburg, Mass.	Apr. 24, 1895.
A. Lawrence Lowell	Trustee, Lowell School of Design, 843 Exchange Bldg.,	Boston, Mass.	Apr. 25, 1901.
Dudley T. Lyall	Sec. Brighton Mills	Passaic, N. J.	Sept. 22, 1896.
William L. Lyall	Treas. Brighton Mills	Passaic, N. J.	Oct. 26, 1892.
Herbert Lyman	505 Sears Bldg., Box 1717,	Boston, Mass.	Oct. 25, 1895.
Otis G. Lynch	Supt. Enterprise Manufg. Co.	Augusta, Ga.	Oct. 25, 1895.
Alvin S. Lyon	Supt. Bigelow Co.	Lowell, Mass.	Apr. 26, 1882.
James R. MacColl	Treas. Lorraine Manufg. Co.	Pawtucket, R. I.	Apr. 24, 1895.
Charles L. Macomber	Pres. Winthrop Cotton Yarn Co.	Taunton, Mass.	Apr. 24, 1895.
Frederick B. Macy,	Treas. Soule Mills,	New Bedford, Mass.	Apr. 25, 1901.
Amos G. Maddox	Supt. Linwood Mill	Linwood, Mass.	Oct. 18, 1900.
Charles T. Main	Mech. and Mill Engineer, Dean & Main 53 State St., 1112 Exchange Bldg.,	Boston, Mass.	Oct. 28, 1885.
Charles R. Makepeace	Mill Engineer Box 973,	Providence, R. I.	Apr. 30, 1890.
A. T. Malcolmson	Agt. C. Bischoff & Co. 19 George St., Box 1104,	Providence, R. I.	Oct. 28, 1897.
Arthur B. Mann	J. H. Martin & Co., Box 465, 99 Franklin St.,	New York, N. Y.	Apr. 25, 1894.
Charles H. Manning	Supt. Amoskeag Manufg. Co.	Manchester, N. H.	Oct. 28, 1885.
Henry F. Mansfield	Gen. Supt. Utica Steam Cotton Mills and Mohawk Valley Cotton Mills	Utica, N. Y.	Apr. 30, 1890.
Paul J. Marrs	Treas. Henderson Cotton Mills	Henderson, Ky.	Oct. 28, 1897.
Albert G. Martin	Supt. Kincaid Manufg. Co. Box 182, Griffin, Spalding County,	Ga.	Apr. 30, 1884.
Henry D. Martin	Supt. J. L. & T. D. Peck Mfg. Co., (Cotton Dept.) 772 North St.,	Pittsfield, Mass.	Apr. 28, 1897.
John R. Mason	523 Broadway,	Fall River, Mass.	Apr. 28, 1897.
Philip A. Mathewson	Supt. King Philip Mills	Box 607, Fall River, Mass.	Apr. 24, 1895.
Scott Maxwell,	Supt. Lanett Cotton Mills	West Point, Ga.	Sept. 26, 1901.
Thomas Mayor	Textile Machinery Thomas Mayor & Son, 26 Olney St.,	Providence, R. I.	Oct. 27, 1880.
Robert McArthur	Agt. Pepperell Mfg. Co.	Biddeford, Me.	Apr. 17, 1872.
Thos. McAuliffe	Supt. Stevens Mfg Co.	Fall River, Mass.	Apr. 27, 1898.
Charles D. McDuffie	Agt. Manchester Mills	Manchester, N. H.	Apr. 21, 1869.
Fred C. McDuffie	Treas. Everett Mills and York Manufg. Co.	P. O. Box 2934, 40 Water St., Boston, Mass.	Oct. 25, 1882.
William G. McLoon	Supt. Lancaster Mills,	Clinton, Mass.	Apr. 27, 1892.

Robert G. McMeehan,	Supt. Hamlet Textile Co.	Woonsocket, R. I.	Sept. 26, 1901.
William P. McMullan	Agt. Naumkeag Steam Cotton Co.	Salem, Mass.	Sept. 27, 1894.
John Tempest Meats	Agt. Mason Machine Works	Taunton, Mass.	Apr. 27, 1887.
Henry P. Meikleham,	Agt. Mass. Mills in Georgia	Lindale, Floyd Co., Ga.	Apr. 26, 1900.
Joseph Mercer	Agt. and Treas. Willimantic Cotton Mills Co.	Willimantic, Conn.	Apr. 24, 1902.
Charles H. Merriman, Jr.	Social Mfg. Co.	Providence, R. I.	Apr. 24, 1895.
W. H. Miles	Agt. Farwell Mills	Lisbon, Me.	Sept. 22, 1896.
R. M. Miller, Jr.	Pres. & Treas. Elizabeth Mills	Charlotte, N. C.	Sept. 29, 1898.
James I. Milliken	Agt. Everett Mills	Lawrence, Mass.	Oct. 26, 1892.
Roscoe S. Milliken	Supt. Nashua Mfg. Co.	Nashua, N. H.	Apr. 29, 1896.
David Milne	C. J. Milne & Sons	Washington Ave. & 11th St., Philadelphia, Pa.	Apr. 28, 1897.
A. B. Mole	Gen. Mgr. Dominion Cotton Mills Co.,	Montreal, P. Q.	Apr. 24, 1895.
Edward A. Mongeon	Supt. Lonsdale Mills	Lonsdale, R. I.	Apr. 24, 1895.
J. R. Montgomery	Pres. The J. R. Montgomery Co.	Windsor Locks, Conn.	Sept. 29, 1898.
George A. Moody	Supt. West Warren Cotton Mills	West Warren, Mass.	Apr. 27, 1899.
Fred W. Moore	Agt. Cordis Mills	P. O. Box 582, Millbury, Mass.	Apr. 27, 1892.
James Sumter Moore	Sec. and Treas. Olympia & Richland Cotton Mills	Columbia, S. C.	Apr. 26, 1900.
George B. Morison	Pres. Ballou Yarn Co.,	78 Chauncy St. Boston, Mass.	Apr. 24, 1902.
Albert H. Morton	Supt. Kitson Machine Co.	Lowell, Mass.	Oct. 28, 1891.
E. P. Morton,	Agt. Stevens Linen Works	Webster, Mass.	Sept. 26, 1901.
Oliver H. Moulton	Supt. Hamilton Manufg. Co.	Lowell, Mass.	Apr. 20, 1865.
Farquharson J. Muir	Mgr. Fort Mill Mfg. Co. and Millfort Mill Co.,	Fort Mill, S. C.,	Apr. 27, 1892.
John Neild	Supt. Grinnell Mfg. Co.	New Bedford, Mass.	Apr. 25, 1901.
Roscius C. Newell	Supt. Palmer Mill	Three Rivers, Mass.	Oct. 25, 1895.
William G. Nichols	Sec. and Treas. Springstein Mills	Chester, S. C.	Oct. 25, 1893.
William M. Nixon	Pres. Atlanta Woolen Mills	Atlanta, Ga.	Oct. 5, 1899.
Albert W. Noone,	Prop. & Mgr. Jos. Noone's Son's Co.	Peterboro, N. H.	Sept. 26, 1901.
Franklin Nourse	Agt. Lawrence Manufg. Co.	Lowell, Mass.	Apr. 24, 1878.
S. Odenheimer	Treas. Lane Mills	New Orleans, La.	Oct. 25, 1893.
Charles K. Oliver	Treas. Mt. Vernon-Woodberry Cotton Duck Co.	346-8 Equitable Bldg., Baltimore, Md.	Sept. 27, 1894.
J. Edward Osborn	Treas. American Linen Co.	Fall River, Mass.	Apr. 28, 1897.
Henry Osgood,	6 Munroe St., P. O. Box 204,	Salem, Mass.	Apr. 25, 1901.
Herbert W. Owen	Supt. Cocheco Mfg. Co.	Dover, N. H.	Oct. 5, 1899.
Oscar L. Owen	Mech. and Mill Eng. Whitin Machine Works	Whitinsville, Mass.	Apr. 25, 1894.
Elmer E. Page	Agt. York Manufg. Co.	Saco, Me.	Apr. 27, 1892.
Francis J. Parker	Treas. Monadnock Mills, 81 Milk St.,	Boston, Mass.	Jan. 15, 1868.

O. B. Parker	Supt. Laurens Cotton Mills	Laurens, S. C.	Apr. 24, 1895.
Samuel L. Parker	Supt. Turners Falls Cotton Mills	Box 627, Turners Falls, Mass.	Apr. 29, 1896.
Walter E. Parker	Agt. Pacific Mills, 217 Haverhill St.,	Lawrence, Mass.	Apr. 25, 1877.
John H. Parks	John H. Parks & Co., 93 Germain St.,	St. John, N. B.	Apr. 24, 1878.
Duncan D. Parmly	Treas. Johnson Mfg. Co. and Dunbar Mills Co.	160 Broadway, New York, N. Y.	Sept. 22, 1896.
Samuel F. Patterson	Pres. and Treas. Thistle Mills Co.	Ilchester, Md.	Oct. 18, 1900.
John W. Pead	Agt. Merrimack Manufg. Co.	Box 1231, Lowell, Mass.	Apr. 26, 1893.
James R. Pearce	Supt. Monaghan Mills	Greenville, S. C.	Oct. 25, 1895.
William C. Peirce	Pres. Elizabeth Mills . 564 Eddy St.,	Providence, R. I.	Apr. 24, 1895.
William D. Pennell	Agt. Hill Manufg. Co.	Lewiston, Me.	Apr. 16, 1873.
Haven C. Perham	Treas. Kitson Machine Co.	Lowell, Mass.	Apr. 30, 1879.
Henry C. Phillips	Supt. Greylock Mills,	North Adams, Mass.	Apr. 25, 1894.
Benjamin Phipps	Merchant	4 Winthrop Sq. Boston, Mass.	Sept. 29, 1898.
Albert R. Pierce	Supt. Pierce Mfg. Corp.	New Bedford, Mass.	Oct. 5, 1899.
Andrew G. Pierce, Jr.	Treas. Rotch Spinning Co. Treas. Pierce Manufg. Corp. Treas. Howland Mills Corp.	P. O. Box, 34, New Bedford, Mass.	Apr. 24, 1895.
Reuben Pilling, Jr.		30 Hudson St., Providence, R. I.	Apr. 29, 1896.
Charles H. Plummer	Agt. Great Falls Manufg. Co.	Somersworth, N. H.	Apr. 25, 1888.
Charles T. Plunkett	Sec. Berkshire Cotton Mfg. Co.	Adams, Mass.	Apr. 28, 1897.
Charles H. Potter,	Supt. Montreal Cotton Co.,	Valleyfield, P. Q.,	Apr. 25, 1901.
Joseph H. Potter, Jr.	Supt. Durfee Mills	Fall River, Mass.	Apr. 27, 1899.
J. F. Powers	Supt. Spinning Mill	Middletown, Conn.	Oct. 5, 1899.
Herbert L. Pratt	Agt. Bates Manufg. Co.	Lewiston, Me.	Oct. 27, 1875.
T. W. Pratt	Pres. West Huntsville Cotton Mill Co.	Huntsville, Ala.	Sept. 22, 1896.
George E. Prest	Supt. No. 1 Harmony Mill	Cohoes, N. Y.	Apr. 24, 1902.
Harry B. Prest	Asst. Supt. Harmony Mills	Cohoes, N. Y.	Apr. 24, 1902.
John E. Prest	Gen. Supt. Harmony Mills	Cohoes, N. Y.	Apr. 17, 1872.
M. W. Quinn	Agt. Hamilton Woolen Co.	Amesbury, Mass.	Oct. 27, 1886.
John W. Ramsbottom	Supt. Samoset Co.	Valley Falls, R. I.	Apr. 24, 1902.
T. G. Ramsdell	Agt. Monument Mills	Housatonic, Mass.	Oct. 30, 1878.
Emory S. Rathbun	Supt. Pequot Mills	Montville, Conn.	Apr. 27, 1899.
M. A. Rawlinson	Supt. Tremont and Suffolk Mills	Lowell, Mass.	Apr. 24, 1895.
John F. Reardon	Agt. Falls Co.	Norwich, Conn.	Apr. 26, 1900.
Robert Redford	Mfr.	Box 28, Lawrence, Mass.	Apr. 26, 1882.
R. S. Reinhardt	Treas. and Mgr. Elm Grove Cotton Mills,	Lincolnton, N. C.	Apr. 27, 1898.
L. B. Renfrew	Treas. Renfrew Mfg. Co.	Adams, Mass.	Oct. 5, 1899.
T. H. Rennie	Supt. Graniteville Mfg. Co.	Graniteville, S. C.	Oct. 18, 1900.
Frederick W. Reynolds,	Supt. Potomska Mills,	Box 299, 20 Fifth St., New Bedford, Mass.	Apr. 26, 1900.

Francis H. Rice . . . . Pres. Holbrook Mfg. Co. . . . . Millbury, Mass. . . . Apr. 28, 1880.
John Bion Richards . . Treas. Davis Mill . . . . . Fall River, Mass. . . . Apr. 24, 1902.
Charles H. Richardson Agt. Lancaster Mills . . . . . Clinton, Mass. . . . Apr. 24, 1889.
W. H. Richmond . . . Supt. Bibb Mill No. 2 . . . . . Macon, Ga. . . . . Oct. 28, 1897.
Walter Rigby . . . . Supt. Ballou Yarn Converting Co. . . . . 189 Charles St., Providence, R. I. . . Apr. 26, 1900.
Charles E. Riley . . . Textile Machinery, C. E. Riley & Co. . . . . 281 Congress St., Box 2815, Boston, Mass. . . . Apr. 25, 1888.
William H. Ritter . . . Gen. Supt. and Purchasing Agt. Johnson & Johnson . . . . . 266 George St., New Brunswick, N. J. Apr. 26, 1900.
George W. Robbins . . Supt. Dyerville Mfg. Co., ... 610 Manton Ave., Providence, R. I. . . Apr. 28, 1897.
Benj. H. Roberts . . . General Mill Supplies 163 Grove St., Fall River, Mass. . . Apr. 26, 1900.
Charles D. Robinson . Supt. Crompton Co. . . . . Crompton, R. I. . . . Sept. 27, 1894.
Edwin A. Robinson . . Asst. Supt. Tremont and Suffolk Mills Lowell, Mass. . . . . Oct. 18, 1900.
William A. Robinson . Manville Co. . . . . Woonsocket, R. I. . Apr. 29, 1896.
William H. Robinson . Supt. No. 3 Harmony Mill . . . . Cohoes, N. Y. . . . Apr. 24, 1902.
W. H. Rose . . . . . Sec'y & Treas. Granby Cotton Mills, Columbia, S. C. . . . Oct. 18, 1900.
John R. Rostron . . . Lancaster Mills . . . . . Clinton, Mass. . . . Sept. 29, 1898.
John K. Russell . . . . . 3003 West York St., Philadelphia, Pa. . . Apr. 29, 1891.

Alfred Sagar . . . . . Supt. Arlington Cotton Mills . . . . . 15 High St., Methuen, Mass. . . Apr. 24, 1902.
Edward H. Sanborn . . Vice Pres. Cold Spring Bleaching and Finishing Works . . . . . North American Bldg., Philadelphia, Pa. . . Oct. 18, 1900.
Richard W. B. Sanderson G. S. Lings & Co., Yarn Merchants . . . . . P. O. Box 1323, Providence, R. I. . . Apr. 24, 1902.
Arnold B. Sanford . . Pres. American Cotton Yarn Exchange . . . . . 67 Chauncy St., Boston, Mass. . . . Oct. 25, 1882.
J. Herbert Sawyer . . . . . 93 Federal St., Boston, Mass. . . . July 19, 1865.
F. C. Sayles . . . . . Pres. Baltic Mills Co. . . . . 204 Banigan Bldg., Providence, R. I. . . Oct. 28, 1897.
George H. Sayward . . . . . Winchester, Mass. . Oct. 29, 1890.
Arnold Schaer . . . . Agt. Warren Manufg. Co. . . . . Warren, R. I. . . . Apr. 24, 1895.
Theodore C. Search . . Pres. Cold Spring Bleaching and Finishing Works . . . . North American Bldg., Philadelphia, Pa. . . Oct. 18, 1900.
Albion K. Searls . . . Supt. Ogden Mill (Harmony Mills) . Cohoes, N. Y. . . . Apr. 24, 1902.
Charles M. Sears . . . Supt. West Point Mfg. Co. . . . . Langdale, Ala. . . . Apr. 27, 1898.
George H. Shapley . . Treas. Silver Lake Co., 78 Chauncy St. . . . . Boston, Mass. . . . . Apr. 29, 1896.
Frank P. Sheldon . . . Mill Engineer and Architect . . . . . Industrial Trust Bldg. Providence, R. I. . . Apr. 25, 1894.
Thomas C. Sheldon . . Agt. Fitchburg Duck Mills . . . . . 8 School St., Fitchburg, Mass. . . Oct. 29, 1884.
Willis S. Shepard . . . Pres. American Net and Twine Co. . Canton, Mass. . . . Apr. 29, 1896.

William F. Sherman	Mill Engineer	107 New Brazer Bldg., 27 State St., Boston, Mass.	Apr. 15, 1874.
Charles M. Shove	Treas. Granite Mills	Box 45, Fall River, Mass.	Oct. 27, 1875.
Herbert H. Shumway	Treas. and Agt. Corr Manufg. Co.	Taunton, Mass.	Apr. 26, 1893.
Francis H. Silsbee	Supt. Cotton Dept. Pacific Mills	Lawrence, Mass.	Apr. 27, 1887.
Nathaniel G. Simonds	Treas. Naumkeag Steam Cotton Co.,	Salem, Mass.	Apr. 27, 1898.
Louis Simpson		Victoria Chambers, Ottawa, Ont.	Apr. 24, 1895.
Abbott E. Slade	Treas. Laurel Lake Mills	863 High St., Fall River, Mass.	Oct. 25, 1893.
Arthur T. Smith	Supt. Langley Manufg Co. Supt. Aiken Manufg. Co.	Langley, S. C.	Oct. 25, 1895.
James Herbert Smith	Supt. Quinebaug Co.	Danielson, Conn.	Apr. 27, 1898.
Joel Smith	Supt. The J. P. King Manufg. Co.	Augusta, Ga.	Oct. 25, 1895.
J. C. Smith	Supt. Chace Mills	Fall River, Mass.	Oct. 28, 1897.
Thomas Henry Smith	Jamestown Cotton Mill	Jamestown, N. Y.	Apr. 30, 1884.
Ellison A. Smyth	Pres. Pelzer Manufg. Co.	Pelzer, S. C.	Oct. 26, 1892.
William S. Southworth	Agt. Mass. Cotton Mills	Box 1230, Lowell, Mass.	Oct. 31, 1888.
Wilton H. Spencer	Textile Manuf.,	7 Exchange Pl., Providence, R. I.	Apr. 27, 1898.
George E. Spofford	Supt. Blackstone Mfg. Co.	Blackstone, Mass.	Apr. 29, 1896.
Henry B. Sprague	Treas. Boston Woven Hose and Rubber Co.	Lynn, Mass.	Oct. 5, 1899.
Leroy Springs	Pres. Lancaster Cotton Mills	Lancaster, S. C.	Oct. 25, 1895.
George R. Stearns	Pres. Riverside Mills	Augusta, Ga.	Apr. 30, 1890.
T. B. Stevenson	Supt. Readville Cotton Mill	Hyde Park, Mass.	Apr. 26, 1900.
Robert Stewart	Asst. Supt. Lonsdale Co.	Ashton, R. I.	Apr. 27, 1899.
Walter F. Stiles	Treas. Orswell Mills	Fitchburg, Mass.	Oct. 25, 1895.
O. W. Stites	Mgr. Commonwealth Cotton Mfg. Co.	Durham, N. C.	Oct. 25, 1895.
B. L. Stowe	Vice-Pres. Eureka Fire Hose Co.	Wilkinson and Arlington Aves., Jersey City, N. J.	Sept. 26, 1901.
Herman F. Straw	Agt. Amoskeag Manufg. Co.	Manchester, N. H.	Oct. 28, 1885.
John Sullivan	Supt. Union Cotton Mfg. Co.	Fall River, Mass.	Apr. 27, 1899.
Timothy Sullivan	Supt. Davol Mills	Fall River, Mass.	Apr. 27, 1899.
Walter H. Summersby	Agt. Atlantic Cotton Mills	Lawrence, Mass.	Oct. 25, 1893.
D. G. Sunderland	Treas. The Pelham Mills	Pelham, S. C.	Oct. 18, 1900.
James O. Sweet	Agt. and Treas. Ashland Cotton Co.	Jewett City, Conn.	Apr. 28, 1886.
Robert Rennie Taft		P. O. Box 1443, Providence, R. I.	Apr. 24, 1895.
Robert W. Taft	Treas. Coventry Co.	Box 1144, Providence, R. I.	Sept. 27, 1894.
George P. Taylor	Treas. Danielsonville Cotton Co. of	Danielson, Conn. Clinton, Mass.	Oct. 27, 1880.
James W. Taylor	Agt. Canoe River Mills	Box 46, Taunton, Mass.	Oct. 26, 1892.
W. Marshall Taylor		111 Nonotuck St., Holyoke, Mass.	Sept. 22, 1896.
Richard Thackeray	Supt. Weetamoe Mills	Fall River, Mass.	Apr. 29, 1885.
S. Willard Thayer	Treas. Dexter Yarn Co.	Pawtucket, R. I.	Sept. 26, 1901.
Earl A. Thissell	Gen. Mgr. Woonsocket Bobbin Co.	Woonsocket, R. I.	Oct. 30, 1878.
Ariel C. Thomas	Agt. Boott Cotton Mills	62 Mt. Vernon St., Lowell, Mass.	Oct. 31, 1888.

Charles E. Thomas . . Treas. Forestdale Manufg. Co. . . . . 44 Prospect St., Woonsocket, R. I. . . Oct. 31, 1883.
Edward W. Thomas . . Gen. Mgr. Erwin, Pearl, Durham, ... Alpine and Cooleemee Cotton Mills, West Durham, N. C. . Apr. 30, 1884.
D. M. Thompson . . . Gen. Mgr. B. B. and R. Knight's Mills . . . . . Box 1442, Providence, R. I. . . Oct. 28, 1885.
James O. Thompson, Jr. Supt. Wamsutta Mills . . . . . New Bedford, Mass. . Oct. 18, 1900.
Ralph E. Thomson . . Supt. Parkhill Manufg. Co., Mill C. Fitchburg, Mass. . . Apr. 25, 1894.
Joseph S. Tidd . . . . Treas. Oakland Mills . . . . . Taunton, Mass. . . . Apr. 27, 1899.
Horace W. Tinkham . Treas. and Agt. Robeson Mills . . . Fall River, Mass. . . Apr. 27, 1899.
W. O. Todd . . . . . Sec. and Treas. Lawton Spinning Co. Box 1125, ... 621 Banigan Building, Providence, R. I. . . Oct. 18, 1900.
James P. Tolman . . . Pres. Samson Cordage Works . . . . . 115 Congress St., Boston, Mass. . . . Oct. 29, 1890.
Daniel A. Tompkins . Pres. Atherton Mills . . . . . Charlotte, N. C. . . . Oct. 25, 1895.
George W. Towne . . . Mgr. Columbus Power Co. . . . . Columbus, Ga. . . . Oct. 26, 1892.
Edward B. Townsend, . Treas. Warwick Mills, ... 53 State St., Room 632, Boston, Mass. . . . Apr. 25, 1901.
Robert B. Treat . . . . Prop. Centreville Cotton Mills . . . Centreville, R. I. . . Sept. 27, 1894.
C. H. Truesdell . . . . Supt. Attawaugan Co. . . . . Killingly, Conn. . . Oct. 29, 1884.
Edmund E. Truesdell . Supt. China, Webster & Pembroke Mills . Suncook, N. H. . Apr. 26, 1876.
Oscar B. Truesdell . . . . . 18 Washington Terrace, Newtonville, Mass. . Oct. 15, 1873.
George E. Tucker . . . Agt. Otis Co. . . . . Ware, Mass. . . . . Oct. 25, 1895.
Philip S. Tuley . . . Pres. and Treas. Louisville Cotton Mills Co. . . . . 1008 Goss Ave., Louisville, Ky. . . . Oct. 18, 1900.
George W. Turner . . Supt. Argo Mills Co. . . . . Gloucester, N. J. . . Apr. 26, 1900.
William D. Twiss . . . Supt. Everett Mills . . . . . Lawrence, Mass. . . April 29, 1896.

Charles T. Upton . . . . . 63 Mt. Vernon St., Lowell, Mass. . . . Apr. 28, 1897.

George A. Vaughan . . Supt. The Putnam Manufg. Co. . . Putnam, Conn. . . . Sept. 22, 1896.
William P. Vaughan . Agt. Putnam Manufacturing Co. . . . . 1041 Banigan Building, Providence, R. I. . . Sept. 29, 1898.
Eugene F. Verdery . . Pres. and Treas. Warren Mfg. Co. . . . . 739 Reynolds St., Augusta, Ga. . . . . Apr. 26, 1900.
James P. Verdery . . . Pres. Enterprise Mfg. Co. . . . . Augusta, Ga. . . . . Apr. 26, 1900.
Frank P. Vogl . . . . Agt. Monadnock Mills . . . . . Claremont, N. H. . . Sept. 27, 1894.

Jude C. Wadleigh . . . Supt. Mass. Cotton Mills . . . . . Lowell, Mass. . . . Oct. 26, 1892.
Herbert E. Walmsley . Agt. Wamsutta Mills . . . . . New Bedford, Mass. . Oct. 29, 1890.
Robinson Walmsley . . Supt. Tecumseh Mills, P. O. Box 246, Fall River, Mass. . . Apr. 27, 1899.
Frederick T. Walsh . . Mgr. Thomas Leyland & Co., Dyestuffs, etc. . . . . 53 India St., Boston, Mass. . . . Apr. 28, 1897.
James A. Walsh . . . Agt. Lewiston Bleachery and Dye Works . . . . . Lewiston, Me. . . . Apr. 27, 1892.

Joseph Watters . . . . Supt. Osborn Mills . . . . . Fall River, Mass. . . Oct. 15, 1873.
F. E. Wattles . . . . Agt. Boscawen Mills . . . . . Penacook, N. H. . . Oct. 5, 1899.
George W. Weeks . . . . . 330 Church St., Clinton, Mass. . . . Apr. 20, 1870.
W. B. Smith Whaley { Mechanical & Mill Engineer / Pres. Richland Cotton Mills / Granby Cotton Mills, } 1328 Main St., Columbia, S. C. Apr. 24, 1895.
H. D. Wheat . . . . . Pres. and Treas. Gaffney Mfg. Co. and Pres. and Treas. . . . . Orient Mfg. Co., Charlotte, N. C., Gaffney, S. C. . . . Apr. 24, 1895.
Channing Whitaker . . Infringement and Patentability of Inventions . . . . . Lowell Machine Shop . . . . . Lowell, Mass. . . . Oct. 15, 1873.
A. Tenny White . . . Supt. Manville Co. . . . . Manville, R. I. . . . Oct. 27, 1887.
Alphonso F. White . . Supt. Forestdale Mfg. Co., ... Forestdale, R. I. . . Apr. 24, 1902.
Charles D. White . . . Agt. Uncasville Mfg. Co. . . . . Norwich, Conn. . . . Oct. 28, 1897.
Arthur F. Whitin . . . Pres. and Treas. Saunders Cotton Mills . . . . . Whitinsville, Mass. . Apr. 24, 1895.
Fred B. Whitin . . . . Agt. and Treas. Uxbridge Cotton Mills, Linwood, Mass. . . Apr. 28, 1897.
Henry T. Whitin . . . Treas. Paul Whitin Manufg. Co. . . Northbridge, Mass. . Apr. 25, 1877.
Alfred N. Whiting . . Sec. and Treas. L. M. Harris Manufg. Co. . . . . 167 Pleasant St., Worcester, Mass. . . Apr. 21, 1875.
William Whitman . . Pres. Arlington Mills, ... P. O. Box 3590, ... 78 Chauncy St., Boston, Mass. . . . . Apr. 25, 1901.
William S. Whitney . . Supervising Engineer, American Woolen Co. . . . . Lawrence, Mass. . . Apr. 24, 1878.
Arthur Whittam . . . Director Textile Dept., Mississippi Agricultural and Mechanical College, ... Agricultural College, Miss., Apr. 27, 1898.
William Whittam, Jr. . Vice Pres. & Gen. Mgr. The William Whittam Textile Co. . . . . Ashville, N. C. . . . Apr. 26, 1893.
George F. Whitten . . Agt. Amory Mfg. Co. . . . . Manchester, N. H. . Oct. 26, 1892.
John H. Whitten . . . Agt. Stark Mills . . . . . Manchester, N. H. . Apr. 27, 1898.
Nelson Whittier . . . Treas. Whittier Mills . . . . . Springfield, Mass. . . Oct. 18, 1900.
W. R. B. Whittier . . Mgr. Whittier Mills . . . Chattahoochee, Fulton Co., Ga. . Oct. 18, 1900.
George A. Wies . . . . Treas. Eureka Fire Hose Co. . . . . 13 Barclay St., New York City . . . Apr. 24, 1902.
Edward B. Wilbur . . Gen. Mgr. Mollohon Mfg. Co. . . . Newbury, S. C. . . . Oct. 30, 1889.
Benjamin Wilcox . . . Treas. City and Bristol Mfg. Co. . . New Bedford, Mass. . Apr. 26, 1900.
Henry M. Wilcox . . . Treas. John Rhodes Warp Co. . . . Millbury, Mass. . . . Apr. 24, 1889.
John B. Wild . . . . Pres. Oneita Knitting Mills . . . . Utica, N. Y. . . . . Apr. 26, 1900.
Eben C. Willey . . . . Treas. Holbrook Mfg. Co. , ... Millbury, Mass. . . Apr. 29, 1896.
Franklin D. Williams . Treas. Fiskdale Mills, ... 87 Milk St., Room 21, Boston, Mass. . . . . Apr. 25, 1901.
Broadus E. Willingham, Sec. and Treas. Willingham Cotton Mills . . . . . Macon, Ga. . . . . Oct. 18, 1900.
Theop. W. Wilmarth . . . . . 1205 Floyd St., Lynchburg, Va. . . . Oct. 31, 1883.
William E. Winchester . Teacher of Cotton Carding and Spinning, Philadelphia . . . . . Textile School, Broad and Pine Sts., Philadelphia, Pa. . . Apr. 24, 1902.
George Wood . . . . Pres. and Treas. Millville Manufg. Co. . . . . 626 Chestnut St., Phila., Pa. . . . . Oct. 16, 1872.

John P. Wood . . . . . Spring Garden and 22d Sts., Philadelphia, Pa. . . Apr. 28, 1897.
Oscar W. Wood . . . Treas. Germantown Spinning Co. . . . . Germantown, Philadelphia, Pa. . . Oct. 18, 1900.
C. J. H. Woodbury . . Secretary and Treasurer . . . . . Lynn, Mass. . . . . Oct. 29, 1879.

Adelbert R. Young . . Supt. Ashland Cotton Co. . . . . Jewett City, Conn. . . Apr. 25, 1894.
James M. Young . . . Mgr. Hamilton Cotton Co. . . . . Hamilton, Ont., Can. Apr. 27, 1899.

ASSOCIATE MEMBERS.

S. B. Alexander, Jr. . . Pres. S. B. Alexander, Jr. Co. . . . Charlotte, N. C. . . . Oct. 18, 1900.
Eugene C. Andres . . Exporter and Importer . . . . . 577 John Hancock Building, Boston, Mass. . . . . Oct. 18, 1900.
Henry B. Ashton . . . Agt. S. A. Felton & Son Co. . . . . 153 Adams St., Medford, Mass. . . . Apr. 26, 1900.
Henry Ashworth . . . Agt. of Elijah Ashworth, Mfr. of Card Clothing . . . . . 89 Globe Mills Ave., Box 427, Fall River, Mass. . . Apr. 28, 1897.

George R. Babbitt . . . Pres. and Gen. Mgr. American Oil Co. . . . . 182 So. Water St., Providence, R. I. . . Apr. 24, 1895.
D. C. Ball . . . . . 27 William St., New York, N. Y. . . Oct. 25, 1895.
Edwin Barnes . . . . Vice Pres. Wm. Firth Co. . . . . 67 Equitable Building, Boston, Mass. . . . . Apr. 26, 1900.
George S. Barnum . . Sec. and Treas. The Bigelow Co. . New Haven, Conn. . Apr. 24, 1895.
Colin C. Bell . . . . Vice-Pres. American Vulcanized Fibre Co., Laminar Dept., ... 1017 Market St., Wilmington, Del. . . Apr. 29, 1896.
Frank P. Bennett . . . Publisher American Wool and Cotton Reporter . . . . . 530 Atlantic Ave., Boston, Mass. . . . Sept. 22, 1896.
William H. Bent . . . Treas. Mason Machine Works . . . Taunton, Mass. . . . April 29, 1896.
F. H. Bishop . . . . . Gen. Mgr. Universal Winding Co. . . . . 95 South St., Boston, Mass. . . . . Apr. 26, 1900.
Arthur T. Bradlee, . . Mgr. Cotton Yarn Dept., Harding, Whitman & Co. . . . . 78 Chauncy St., Boston, Mass. . . . . Apr. 25, 1901.
J. Payson Bradley . . . The Kehew Bradley Co. . . . . 24 Purchase St., Boston, Mass. . . . Apr. 24, 1895.
J. Frank Braids . . Mgr. Grease & Oil Dept., Charles S. Bush Co. . . . . 212 Weybosset St., Providence, R. I. . . Apr. 28, 1897.

Henry Gordon Brinckerhoff, N. E. Mgr. Green Fuel Economizer Co., Box 2654 . . . . . Room 1053, Exchange Bldg., 53 State St., Boston, Mass. Sept. 22, 1896.
D. Russell Brown . . . Pres. Brown Bros. Co. . . . . 62 Exchange Place, Providence, R. I. . . Apr. 24, 1895.
H. Martin Brown . . . Treas. U. S. Bobbin & Shuttle Co. . Providence, R. I. . . Apr. 24, 1895.
Percy H. Brundage . . . . . 49 Wall St., New York, N. Y. . . Oct. 5, 1899.

John H. Burghardt . . Page Belting Co. . . . . 31 Pearl St., Boston, Mass. . . . Apr. 24, 1895.
Eugene E. Burnham . . Belt Mfr. . . . . 252 Lowell St., Lawrence, Mass. . . Oct. 25, 1895.
Fred N. Bushnell . . . Mech. Supt. Narragansett Electric Light Co. . . . . 3 South St., Providence, R. I. . . Sept. 29, 1898.
Harry W. Butterworth . Sec. H. W. Butterworth & Sons . . . . . York and Cedar Sts., Philadelphia, Pa. . . Oct. 28, 1897.
James Butterworth . Pres. H. W. Butterworth & Sons Co. . . . . York and Cedar Sts., Philadelphia, Pa. . . Apr. 24, 1895.

Albert L. Calder, 2nd . Cotton Dealer . . . . . 28 Market Square, Box 206, Providence, R. I. . . Apr. 26, 1900.
French Campbell . . . Commission Merchant, 75 Granite St., Manchester, N. H. . Oct. 28, 1897.
Malcolm Campbell . . Gen. Mgr. Woonsocket Machine and Press Co. . . . . Woonsocket, R. I. . . Apr. 24, 1895.
W. W. Carey . . . . . Mfr. Wood Rim Pulleys and Wood Working Machinery . . . . . 514 Broadway, Lowell, Mass. . . . . Apr. 24, 1895.
Albert C. Case . . . . Pres. American Cotton Co. . . . . 25 Broad St., New York, N. Y. . . Sept. 26, 1901.
J. E. Cheesman . . . . Gen. Mgr. Cheesman Cotton Gin Co. . . . . 27 William St., New York, N. Y. . . Oct. 5, 1899.
Charles H. Child . . . Treas. Standard Mill Supply Co. . . . . P. O. Box 1406, 77 Exchange Place, Providence, R. I. . . Apr. 24, 1895.
Henry C. Clark . . . . Pres. Charlotte Supply Co. . . . . Charlotte, N. C. . . . Apr. 27, 1898.
C. C. Cowan . . . . . 372 Front St., Memphis, Tenn. . . Oct. 5, 1899.
Thomas G. Cox . . . . Selling Agt. Mason Machine Works . . . . . Box 316, Taunton, Mass. . . . Apr. 24, 1895.
George Crompton . . . . . Worcester, Mass. . . Oct. 28, 1897.
C. F. Curwen . . . . Treas. Dinsmore Mfg. Co. . . . . Salem, Mass. . . . . Apr. 27, 1899.
Joseph L. Cushing . . Mfr. of Cotton Conveying Systems, Daniel Cushing & Co., ... Box 885, Lowell, Mass. . . . . Apr. 26, 1900.

Frederick I. Dana . . . Sec. and Mgr. Thomas Phillips Co. Providence, R. I. . . Apr. 24, 1895.
E. W. Davenport . . . Mgr. Crompton & Knowles Loom Works . . . . . Providence, R. I. . . Sept. 26, 1901.
John O. DeWolf, . . . Mech. Engineer, 1012 Tremont Bldg., Boston, Mass. . . . Apr. 25, 1901.
C. E. W. Dow . . . . So. Agt. American Moistening Co. & Wm. Firth Co. . . . . Room 813, Empire Bldg., Box 410, Atlanta, Ga. . . . Apr. 24. 1895.
Frederick A. Downes . Sec. Factory Mutual Fire Insurance Cos. . . . . 925 Chestnut St., Philadelphia, Pa. . . Oct. 28, 1897.
W. L. Draper . . . . Mgr. Dodge Mfg. Co. . . . . Atlanta Branch, 522 Prudential Building, Atlanta, Ga. . . . Oct. 18, 1900.

Fred W. Easton, . . . Treas. Easton & Burnham Machine Co., ... 180 Weeden St., Pawtucket, R. I. . . Apr. 25, 1901.
G. B. Emmons . . . . Pres. Emmons Loom Harness Co. . . . . May St., Lawrence, Mass. . . Oct. 25, 1895.
T. C. Entwistle . . . . Treas. T. C. Entwistle Co. . . . . 297 Market St., Lowell, Mass. . . . . Apr. 24, 1895.

D. D. Felton . . . . . Treas. S. A. Felton & Son Co. . . . Manchester, N. H. . Apr. 24, 1895.
John W. Ferguson . . Contractor . . . . . - Paterson Nat. Bank Bldg., Paterson, N. J. . . . Apr. 24, 1895.
J. Herbert Foster . . . Cotton Broker . 10 South Water St., Providence, R. I. . . Apr. 24, 1895.
Merrill A. Furbush . . . . . 2015 North 33rd St., Philadelphia, Pa. . . Oct. 28, 1897.
John T. Fyans . . . . Agt. Fyans, Frazer & Blackway Co. . . . . 411 Beach St., Fall River, Mass. . . Apr. 28, 1897.

H. P. Garland . . . . Treas. Loom Picker Co. . . . . Biddeford, Me. . . . Oct. 25, 1895.
Royal W. Gates . . . . Josiah Gates & Sons, Belting . . . . . 307 Market St., Lowell, Mass. . . . Apr. 24, 1895.
Rufus B. Goff . . . . Pres. Standard Mill Supply Co. . . . . 77 Exchange Pl., Box 714, Providence, R. I. . . Apr. 28, 1897.
Sumner S. Gould . . . Mgr. Lowell Branch American Card Clothing Co. . . . . 112 Fremont St., Lowell, Mass. . . . Oct. 5, 1899.
William S. Granger . . Prest. Granger Foundry & Machine Co., Providence, R. I. . Apr. 24, 1895.
Henry T. Grant, Jr. . . Pres. Mercantile Mutual Fire Ins. Co. . . . . Box 1153, 723 Banigan Building, Providence, R. I. . . Oct. 28, 1897.
Arthur F. Gray . . . . Architect and Mill Engineer . . . . . 53 State St., Room 509, Boston, Mass. . . . Oct. 18, 1900.
Samuel M. Green . . . . . Holyoke, Mass. . . . Apr. 24, 1902.
Edwin Farnham Greene Pres. Lockwood, Greene & Co. . . . . 93 Federal St., Boston, Mass. . . . Apr. 24, 1902.

A. Walter Harris . . . Treas. A. W. Harris Oil Co. . . . . 326 So. Water St., Providence, R. I. . . Oct. 25, 1895.
Alfred H. Hartley . . Dealer in Oils and Mill Supplies . . . . . Box 409, Fall River, Mass. . . Oct. 28, 1897.
Jerome Hill . . . . . Pres. Jerome Hill Cotton Co. . . . . 334 Front St., Memphis, Tenn. . . . Apr. 29, 1896.
Richard H. Hill . . . Gen. Sales Agt. James Hunter Machine Co. . . . . 70 Kilby St., Boston, Mass. . . . . Apr. 26, 1900.
Alfred K. Hobbs . . . Rubber, Leather and Mill Supplies . Manchester, N. H. . Oct. 18, 1900.
John Hogg . . . . . Smith, Hogg & Gardiner, 144 Essex St., Boston, Mass. . . . Apr. 27, 1899.
Henry A. Holcomb . . . . . Box 249, New Bedford, Mass. . Oct. 25, 1895.
Henry S. Houghton, Sr., Mfr. Grids and Beaters, 61 Pond St., Woonsocket, R. I. . Apr. 28, 1897.
Lewis T. Houghton . . Mfr. Thread Boards and Thread Guides . . . . . 997 Main St., Worcester, Mass. . . Sept. 26, 1901.
A. H. Howard . . . . Treas. Howard Bros. Mfg. Co. . . . . P. O. Box 54, Worcester, Mass. . . Sept. 26, 1901.
Frederic W. Howe . . Selling Agt. Crompton & Knowles Loom Works . . . . . Box 899, Providence, R. I. . . Apr. 24, 1902.
Lemuel R. Howe . . . Importer & Dealer in Dye Stuffs, Howe, Fuller & Trunkett, ... 92 State St., Boston, Mass. . . . Apr. 25, 1901.
C. H. Hutchins . . . . Pres. Crompton & Knowles Loom Works . . . . . Worcester, Mass. . . Oct. 25, 1895.

Daniel Jackson . . . . Cotton Buyer B. B. and R. Knight, . Providence, R. I. . . . Apr. 24, 1902.
David Jackson . . . . Gen. Mgr. Jackson Pat. Shell Roll Co., Pawtucket, R. I. . . . Apr. 24, 1895.

Lawrence M. Keeler . Whitin Machine Works . . . . . Whitinsville, Mass. . Sept. 26, 1901.
William B. Kehew . . The Kehew-Bradley Co., ... 24 Purchase St., Boston, Mass. . . . Apr. 24, 1895.
James H. Kendall . . Edward Kendall & Sons . . . . . Cambridgeport, Mass., Sept. 29, 1898.
John E. Kendrick . . . Vice-Pres. American Supply Co. . . . . Box 822, Providence, R. I. . . . Oct. 5, 1899.
Frank B. Kenney . . . Kitson Machine Co. . . . . Lowell, Mass. . . . Oct. 5, 1899.

W. C. Langford . . . Salesman, . . . 86 Weybosset St., Providence, R. I. . . . Apr. 27, 1899.
Josiah M. Lasell . . . Asst. Treas. Whitin Machine Works, Whitinsville, Mass. . Apr. 24, 1895.
Samuel D. Lawton . . Treas. Fall River Machine Co. . . . Fall River, Mass. . . . Oct. 18, 1900.
John H. Lorimer . . . Builder of Textile Machines . . . . . Ontario and Lawrence Sts., Philadelphia, Pa. . . . Oct. 28, 1897.
Sanford E. Loring . . Con. Architect, 104 Everson Bldg., . Syracuse, N. Y. . . . Apr. 24, 1902.
Stephen C. Lowe . . . Agt. John Hetherington & Sons, Ltd., New Bedford, Mass. . Oct. 25, 1895.
Francis E. Macomber . Mill Supplies . . . . 21 Pearl St., Boston, Mass. . . . . Apr. 26, 1900.
Fay H. Martin . . . . Pres. Textile Machinery Co. . . . . 66 State St., Boston, Mass. . . . . Sept. 26, 1901.
Percy H. de Mauriac . Cotton Yarn Commission Merchant . . . . . 78 Chauncy St., Boston, Mass. . . . Apr. 24, 1902.
F. H. Maynard . . . . Gen. Bus. Mgr. Gen. Fire Extinguisher Co. . . . . Providence, R. I. . . . Apr. 24, 1895.
John McCullough, . . . Cotton Waste Merchant . . . . . New Bedford, Mass. . April 25, 1901.
D. E. McGaw . . . . Gen. Mgr. Aragon Mills . . . . . Aragon, Ga. . . . . Oct. 18, 1900.
H. G. McKerrow . . . Textile Machinery Importer . . . . . 31 State St., Boston, Mass. . . . Sept. 22, 1896.
D. K. McLaren . . . . Mfr. of Leather Belting 751 Craig St., Montreal, P. Q., Can. Apr. 26, 1900.
George H. Meader . . Steam Appliances . . 38 Pearl St., Boston, Mass. . . . Apr. 24, 1895.
John R. Mitchell . . . Mitchell-Bissell Co., 362 Bourse Bldg., Philadelphia, Pa. . . Oct. 18, 1900.
Charles B. Moore . . . Mgr. Knowles Steam Pump Works . . . . . 54 Oliver St., Boston, Mass. . . . . Apr. 26, 1900.

Robert W. Neff . . . . Chemical Mfr. . . . . 22 India Sq., Boston, Mass. . . . Apr. 24, 1902.
John H. Nelson . . . . Treas. William Firth Co. . . . . 67 Equitable Building, Box. 1460, Boston, Mass. . . . . Apr. 26, 1900.
William R. Noone . . . . . 102 South St., Boston, Mass. . . . Oct. 28, 1897.

Sidney B. Paine . . . General Electric Co., 200 Summer St., Boston, Mass. . . . Apr. 24, 1895.
William F. Parish, Jr. . Engineer, Vacuum Oil Co. (Technical Department) . . . . . 101 Milk St., Boston, Mass. . . . . Apr. 24, 1902.
Arthur Parkinson . . . Selling Agt. Arabol Mfg. Co. . . . . 13 Gold St., New York, N. Y. . . Apr. 28, 1897.

Stephen Minot Pitman . Sec'y Narragansett Mutual Fire Insurance Co. . . . . 721 Banigan Bldg., Box 315, Providence, R. I. . . Apr. 24, 1895.
Vladimir P. Polevoy . . Agent Jaroslav Cotton Mill, Russia . 120 Broadway, N. Y. Apr. 28, 1897.
Charles A. M. Praray . Chas. A. M. Praray & Co., Architect and Mill Engineer . . . . . 832 and 833 Banigan Building, Providence, R. I. . . Apr. 28, 1897.

Charles F. Randall . . Expert in Textiles . . . . . Room 350, Tremont Building, Boston, Mass. . . . Apr. 24, 1895.
Peleg A. Rhodes . . . Inspector of Cotton Mills . . . . . P. O. Box 315, Providence, R. I. . . Oct. 5, 1899.
Richard H. Rice . . . Treas. Providence Engineering Works . . . . . 521 So. Main St., Providence, R. I. . . Apr. 24, 1895.
E. R. Richardson . . . Asst. Treas. Howard & Bullough American Machine Co., Ltd. . . . . Box 678, Pawtucket, R. I. . . Apr. 26, 1900.
C. E. Roberts . . . . Mgr. Hartford Steam Boiler Inspection & Insurance Co. . . . . 125 Milk St., Boston, Mass. . . . Apr. 24, 1895.
Louis E. Robinson . . Cotton Agent Sea Island Cotton . . . . . 36 So. Water St., Providence, R. I. . . Oct. 28, 1897.
George I. Rockwood, . Mechanical Engineer, 62 Summer St., Worcester, Mass. . . Apr. 25, 1901.
E. A. Rusden . . . . Treas. and Gen. Mgr. Rusden Machine Co. . . . . Warren, R. I. . . . Oct. 18, 1900.
John M. Russell . . . . Treas. Crompton & Knowles Loom Works . . . . . Worcester, Mass. . . Oct. 25, 1895.

Dwight Seabury . . . Mill Engineer . . . 12 East Ave., Pawtucket, R. I. . . Apr. 25, 1901.
William N. Shaw . . . Treas. The Geo. W. Stafford Co. . . Readville, Mass. . . Apr. 24, 1902.
J. A. Shepherd . . . . Sales Agt. The Stirling Co. . . . . 53 State St., Room 631, Exchange Building, Boston, Mass. . . . Oct. 18, 1900.
Harry M. Smith . . . Vice-Pres. Standard Mill Supply Co. . . . . 77 Exchange Pl., Box 714, Providence, R. I. . . Apr. 28, 1897.
R. Paul Snelling . . . Treas. Saco and Pettee Machine Shops . . . . . Newton Upper Falls, Mass. . Sept. 22, 1896.
Henry C. Spence . . . Gen. Mgr. Metallic Drawing Roll Co. Indian Orchard, Mass. Apr. 24, 1895.
George W. Stafford . . Pres. and Gen. Mgr. Geo. W. Stafford Co. . . . . Readville, Mass. . . Apr. 24, 1895.
H. E. Stafford . . . . Asst. Treas. Geo. W. Stafford Co. . Readville, Mass. . . Oct. 18, 1900.
James Strang . . . . Selling Agt. Metallic Drawing Roll Co. . . . . 123 Hampden St., Indian Orchard, Mass. Oct. 28, 1897.
William H. Stratton . . Mgr. Factory Insurance Association . . . . . 95 Pearl St., Hartford, Conn. . . Apr. 28, 1897.
Daniel J. Sully . . . . Cotton Broker, T. M. Reynolds & Co., ... 34 South Water St., Providence, R. I. . . Apr. 24, 1895.
John Sykes, J. P. . . . Pres. English Card Clothing Co. . . . . Acre House, Huddersfield, Eng. . Oct. 18, 1900.

Cyrus A. Taft	Agt. Whitin Machine Works	Whitinsville, Mass.	Apr. 24, 1895.
Charles F. Taylor	Successor to Burgess Cop Tube Co.,	21 Eddy St., Providence, R. I.	Apr. 27, 1898.
George C. Tewksbury	Eastern Mgr. The Underfeed Stoker Co. of America	721 Exchange Bldg., Boston, Mass.	Apr. 24, 1902.
James T. Thornton	Vice-Pres. A. B. Pitkin Machinery Co.	Providence, R. I.	Oct. 18, 1900.
William V. Threlfall	Agt. Saco and Pettee Machine Shops,	Biddeford, Me.	Apr. 24, 1895.
Rienzi W. Thurston	Machinery Manufacturer	Fall River, Mass.	Oct. 18, 1900.
H. A. Tillinghast,	Sec. and Treas. Granger Foundry & Mach. Co.,	Providence, R. I.	Apr. 25, 1901.
A. Curtis Tingley	Treas. National Ring Traveler Co.	257 West Exchange St., Providence, R. I.	Sept. 22, 1896.
Allison W. Trafford	Mfr. of Ring Travelers	116 Pocasset St., Fall River, Mass.	Apr. 26, 1900.
Frank H. Underwood	Resident Mgr. Dodge Mfg. Co.	137 Purchase St., Boston, Mass.	Apr. 29, 1896.
Clement A. Wakefield	Selling Agt. Saco & Pettee Machine Shops,	Biddeford, Me.	Apr. 25, 1901.
Justin A. Ware	Crompton & Knowles Loom Works	Worcester, Mass.	Oct. 25, 1895.
J. F. Warren	Treas. J. F. & W. H. Warren Co.	44 Vine St., Worcester, Mass.	Apr. 24, 1902.
Lettice R. Washburn	Mill Contractor, 235 North Water St., New Bedford, Mass.		Oct. 5, 1899.
Walter S. Watson	Haworth & Watson, Mfrs. Paper Tubes for Textile Manufg.	Box 996, Lowell, Mass.	Oct. 25, 1895.
Robert C. Webster	Mgr. Barber & Colman	11 Pemberton Sq., Boston, Mass.	Apr. 24, 1902.
Stephen M. Weld,	Cotton Buyer	89 State St., Boston, Mass.	Apr. 27, 1899.
William R. West	Roll Coverer	830 Purchase St., New Bedford, Mass.	Sept. 22, 1896.
W. W. White	Agent Holyoke Machine Co.	Worcester, Mass.	Apr. 27, 1899.
G. Marston Whitin	Treas. Whitin Machine Works	Whitinsville, Mass.	Apr. 24, 1895.
Fred A. Wilde	Gen. Mgr. The A. T. Atherton Machine Co.	Prairie Ave., Pawtucket, R. I.	Apr. 28, 1897.
Erving Yale Woolley	Stoddard, Haserick, Richards & Co.	152 Congress St., Boston, Mass.	Apr. 24, 1895.

Honorary Members	4
Active Members	528
Associate Members	149
Total Membership	681

MEMBERS OF THE ASSOCIATION,

May 1, 1902.

ARRANGED BY STATES.

MAINE.

Auburn	William Hayes	Barker Mill.
Biddeford	H. P. Garland	Loom Picker Co.
Biddeford	Robert McArthur	Pepperell Mfg. Co.
Biddeford	William V. Threlfall	Saco & Pettee Machine Shops.
Biddeford	Clement A. Wakefield	Saco & Pettee Machine Shops.
Brunswick	Russell W. Eaton	Cabot Manufg. Co.
Kennebunk	Robert W. Lord	R. W. Lord & Co.
Lewiston	George W. Bean	Androscoggin Mills.
Lewiston	H. B. Estes	Continental Mills.
Lewiston	William D. Pennell	Hill Manufg. Co.
Lewiston	Herbert L. Pratt	Bates Manufg. Co.
Lewiston	James A. Walsh	Lewiston Bleachery and Dye Works
Lisbon	W. H. Miles	Farwell Mills.
Portland	Lyman M. Cousens	Dana Warp Mills.
Saco	James G. Garland	
Saco	Elmer E. Page	York Manufg. Co.
Sanford	Louis B. Goodall	Goodall Worsted Co.
Westbrook	Philip Dana	Dana Warp Mills.
Westbrook	Woodbury K. Dana	Dana Warp Mills.

NEW HAMPSHIRE.

Charlestown	Samuel Webber	Hydraulic Engineer.
Claremont	Frank P. Vogl	Monadnock Mills.
Dover	Charles H. Fish	Cocheco Manufg. Co.
Dover	George A. Hurd	Cocheco Manufg. Co.
Dover	Herbert W. Owen	Cocheco Mfg. Co.

Exeter	George E. Kent	Exeter Manufg. Co.
Exeter	Hervey Kent	Exeter Manufg. Co.
Greenville	Frederick W. Ely	Columbian Manufg. Co.
Hooksett	Stephen N. Bourne	Dundee Mills.
Manchester	Henry Deane Bourne	Hooksett Manufg. Co.
Manchester	French Campbell	75 Granite St.
Manchester	George A. Clark	Manchester Mills.
Manchester	D. D. Felton	S. A. Felton & Son Co.
Manchester	Alfred K. Hobbs	Rubber, Leather and Mill Supplies.
Manchester	Elliott Cowdin Lambert	Amoskeag Manufg. Co.
Manchester	Charles H. Manning	Amoskeag Manufg. Co.
Manchester	Charles D. McDuffie	Manchester Mills.
Manchester	Herman F. Straw	Amoskeag Manufg. Co.
Manchester	George F. Whitten	Amory Manufg. Co.
Manchester	John H. Whitten	Stark Mills.
Milford	M. F. Foster	
Milford	Frank E. Kaley	Morse & Kaley Manufg. Co.
Nashua	William D. Cadwell	Nashua Manufg. Co.
Nashua	William H. Cadwell	Jackson Co.
Nashua	Roscoe S. Milliken	Nashua Mfg. Co.
Penacook	Marcellus Gould	N. H. Spinning Mills.
Penacook	F. E. Wattles	Boscawen Mills.
Peterboro	Albert W. Noone	Jos. Noone's Son's Co.
Salmon Falls	O. S. Brown	Salmon Falls Manufg. Co.
Somersworth	Charles H. Plummer	Great Falls Manufg. Co.
Suncook	David L. Jewell	China, Webster & Pembroke Mills.
Suncook	Edmund E. Truesdell	China, Webster & Pembroke Mills.

VERMONT.

North Pownal	Thomas Armstrong	North Pownal Manufg. Co.

MASSACHUSETTS.

Adams	John S. Adams, Jr.	Adams Bros. Manufg. Co.
Adams	Z. D. Hall	Berkshire Cotton Manufg. Co.
Adams	Emil Kipper	Renfrew Mfg. Co. and Windsor Print Works.
Adams	Charles T. Plunkett	Berkshire Cotton Manufg. Co.
Adams	L. B. Renfrew	Renfrew Mfg. Co.
Amesbury	M. W. Quinn	Hamilton Woolen Co.
Andover	John W. Bell	Smith & Dove Manufg. Co.
Belmont	John Kilburn	
Blackstone	George E. Spofford	Blackstone Manufg. Co.
Bondsville	Elmer G. Childs	Boston Duck Co.
Boston	Charles B. Amory	Hamilton Mfg. Co.

Boston	Frederic Amory	Nashua Mfg.Co. and Jackson Mfg.Co
Boston	Eugene C. Andres	577 John Hancock Building.
Boston	Edward Atkinson	Boston Mfrs. Mut. Fire Ins. Co.
Boston	E. W. Atkinson	Stoddard, Haserick, Richards & Co.
Boston	Nathaniel F. Ayer	Farwell Bleachery.
Boston	Edwin Barnes	Wm. Firth Co.
Boston	Frank P. Bennett	Am. Wool and Cotton Reporter.
Boston	F. H. Bishop	Universal Winding Co.
Boston	Arthur T. Bradlee	Harding, Whitman & Co.
Boston	J. Payson Bradley	The Kehew-Bradley Co.
Boston	Henry Gordon Brinckerhoff	Green Fuel Economizer Co.
Boston	John H. Burghardt	Page Belting Co.
Boston	Frank B. Comins	American Moistening Co.
Boston	Sidney Coolidge	Stark Mills.
Boston	Alphonse S. Covel	Tremont and Suffolk Mills.
Boston	Augustus De Cort	Beacon Mfg. Co.
Boston	P. Y. DeNormandie	Pepperell Mfg. Co.
Boston	Frederic C. Dumaine	Amory Mfg. Co.
Boston	John O. DeWolf	Mech. Engineer.
Boston	Ambrose Eastman	53 State St., Room 904.
Boston	William Firth	Am. Moist. Co. and Wm. Firth Co.
Boston	Alfred M. Goodale	Boston Mfg. Co.
Boston	Arthur F. Gray	53 State St., Room 509.
Boston	Edwin Farnham Greene	Lockwood, Greene & Co.
Boston	Richard H. Hill	Jas. Hunter Machine Co.
Boston	William H. Hill	Windsor Co. and Renfrew Mfg. Co.
Boston	Franklin W. Hobbs	Arlington Mills.
Boston	John Hogg	Smith, Hogg & Gardiner.
Boston	Henry S. Howe	Dry Goods Commission.
Boston	Lemuel R. Howe	Howe, Fuller & Trunkett.
Boston	Charles W. Hubbard	Ludlow Mfg. Associates.
Boston	William B. Kehew	The Kehew-Bradley Co.
Boston	Evan Arthur Leigh	70 Kilby St.
Boston	William C. Lovering	Whittenton Mfg. Co.
Boston	A. Lawrence Lowell	Lowell School of Design.
Boston	Herbert Lyman	P. O. Box 1717.
Boston	Francis E. Macomber	21 Pearl St.
Boston	Charles T. Main	Dean & Main.
Boston	Fay H. Martin	Textile Machinery Co.
Boston	Percy H. de Mauriac	Cotton Yarn Commission Merchant.
Boston	Fred C. McDuffie	Everett Mills and York Mfg. Co.
Boston	H. G. McKerrow	31 State St.
Boston	George H. Meader	38 Pearl St.
Boston	Charles B. Moore	Knowles Steam Pump Works.
Boston	George B. Morison	Ballou Yarn Co.
Boston	Robert W. Neff	Chemical Mfr.
Boston	John H. Nelson	Wm. Firth Co.

Boston	William R. Noone	102 South St.
Boston	Sidney B. Paine	General Electric Co.
Boston	William F. Parish, Jr.	Vacuum Oil Co. (Tech. Dept.)
Boston	Francis J. Parker	Monadnock Mills.
Boston	Benjamin Phipps	4 Winthrop Sq.
Boston	Henry Smith Pritchett, LL.D.	Mass. Institute of Technology.
Boston	Charles F. Randall	350 Tremont Building.
Boston	Charles E. Riley	C. E. Riley & Co.
Boston	C. E. Roberts	Hartford Steam Boiler Insp. & Ins.Co.
Boston	Arnold B. Sanford	American Cotton Yarn Exchange.
Boston	J. Herbert Sawyer	93 Federal St.
Boston	George C. Tewksbnry	The Underfeed Stoker Co. of America
Boston	George H. Shapley	Silver Lake Co.
Boston	J. A. Shepherd	The Stirling Co.
Boston	William F. Sherman	27 State St.
Boston	James P. Tolman	Samson Cordage Works.
Boston	Edward B. Townsend	Warwick Mills.
Boston	Frank H. Underwood	Dodge Mfg. Co.
Boston	Frederick T. Walsh	Thomas Leyland & Co.
Boston	Robert C. Webster	Barber & Colman.
Boston	Stephen M. Weld	89 State St.
Boston	William Whitman	Arlington Mills.
Boston	Franklin D. Williams	Fiskdale Mills.
Boston	Erving Yale Woolley	Stoddard Haserick, Richards & Co.
Cambridgeport	James H. Kendall	Edward Kendall & Sons.
Canton	Willis S. Shepard	Amer. Net & Twine Co.
Chicopee Falls	Henry A. Bailey	Chicopee Manufg. Co.
Clinton	William G. McLoon	Lancaster Mills.
Clinton	Charles H. Richardson	Lancaster Mills.
Clinton	John R. Rostron	Lancaster Mills.
Clinton	George P. Taylor	Danielsonville Cotton Co.
Clinton	George W. Weeks	330 Church St.
Easthampton	George A. Ayer	West Boylston Co.
East Hampton	William B. Fittz	
Fall River	F. S. Akin	Cornell Mills.
Fall River	Henry Ashworth	Agt. for Card Clothing Manufr.
Fall River	John P. Bodge	Arkwright Mills.
Fall River	Jefferson Borden, Jr.	Fall River Bleachery Co.
Fall River	Nathaniel B. Borden	Barnard Manufg. Co.
Fall River	Richard B. Borden	Richard Borden Mfg. Co.
Fall River	Thomas J. Borden	326 North Main St.
Fall River	Isaac A. Brown	Narragansett Mills.
Fall River	George A. Chace	Bourne Mills.
Fall River	Simeon B. Chase	King Phillip Mills.
Fall River	John A. Collins	American Linen Co.
Fall River	Bradford D. Davol	Barnard Manufg. Co.
Fall River	Frank H. Dwelly	Tecumseh Mills.

Fall River	David H. Dyer	D. H. Dyer & Son.
Fall River	William Evans	Wampanoag Mills.
Fall River	Charles F. Farrar	22 Coggeshall St.
Fall River	John T. Fyans	Fyans, Frazer & Blackway Co.
Fall River	Arthur M. Hamilton	Hargraves and Parker Mills.
Fall River	John F. Hamlet	P. O. Box 160
Fall River	Alfred H. Hartley	Oils and Mill Supplies.
Fall River	Samuel E. Hathaway	Fall River Iron Works Co.
Fall River	William Hathaway	Barnard Mfg. Co.
Fall River	William B. Hawes	P. O. Box 733.
Fall River	George H. Hills	Davol Mills and Stevens Mfg. Co.
Fall River	William P. Holt	Barnaby Mills.
Fall River	George H. Law	Merchants' Mfg. Co.
Fall River	Samuel D. Lawton	Fall River Machine Co.
Fall River	Leontine Lincoln	Seaconnet Mills.
Fall River	John R. Mason	523 Broadway.
Fall River	Philip A. Mathewson	King Philip Mills.
Fall River	Thomas McAuliffe	Stevens Manufg. Co.
Fall River	J. Edward Osborn	American Linen Co.
Fall River	Joseph H. Potter, Jr.	Durfee Mills.
Fall River	John Bion Richards	Davis Mill.
Fall River	Benj. H. Roberts	163 Grove St.
Fall River	Charles M. Shove	Granite Mills.
Fall River	Abbott E. Slade	Laurel Lake Mills.
Fall River	J. C. Smith	Chace Mills.
Fall River	John Sullivan	Union Cotton Manufg. Co.
Fall River	Timothy Sullivan	Davol Mills.
Fall River	Richard Thackeray	Weetamoe Mills.
Fall River	Rienzi W. Thurston	Machinery Manufacturer.
Fall River	Horace W. Tinkham	Robeson Mills.
Fall River	Allison W. Trafford	Mfr. Ring Travelers.
Fall River	Robinson Walmsley	Tecumseh Mills.
Fall River	Joseph Watters	Osborn Mills.
Fisherville	Albert W. Dimick	Fisher Mfg. Co.
Fisherville	Charles W. Fisher	Fisher Mfg. Co.
Fiskdale	John Gregson	Fiskdale Mills.
Fitchburg	George P. Grant, Jr.	Grant Yarn Co.
Fitchburg	W. E. Keach	Grant Yarn Co.
Fitchburg	John Leiper	Fitchburg Worsted Mills.
Fitchburg	Arthur H. Lowe	Parkhill Manufg Co.
Fitchburg	David Lowe	Parkhill Manufg. Co.
Fitchburg	Thomas C. Sheldon	Fitchburg Duck Mills.
Fitchburg	Walter F. Stiles	Orswell Mills.
Fitchburg	Ralph E. Thompson	Parkhill Manufg. Co.
Great Barrington	Jno. H. C. Church	Monument Mills.
Holyoke	Samuel M. Green	
Holyoke	Ernest Lovering	Lyman Mills.

Holyoke	W. Marshall Taylor	111 Nonotuck St.
Hopedale	Eben S. Draper	Draper Co.
Hopedale	George A. Draper	Draper Co.
Hopedale	George Otis Draper	Draper Co.
Hopedale	William F. Draper	Draper Co.
Hopedale	William F. Draper, Jr.	Draper Co.
Hopedale	Frank J. Dutcher	Shaw Stocking Co.
Housatonic	T. G. Ramsdell	Monument Mills.
Hyde Park	Calvin H. Lee	Readville Cotton Mills.
Hyde Park	T. B. Stevenson	Readville Cotton Mill.
Indian Orchard	William C. Godfrey	Indian Orchard Co.
Indian Orchard	Henry C. Spence	Metallic Drawing Roll Co.
Indian Orchard	James Strang	Metallic Drawing Roll Co.
Ipswich	James W. Brown	Box 312.
Lawrence	William A. Barrell	Lawrence Duck Co.
Lawrence	Eugene E. Burnham	252 Lowell St.
Lawrence	G. B. Emmons	Emmons Loom Harness Co.
Lawrence	William D. Hartshorne	Arlington Mills.
Lawrence	James I. Milliken	Everett Mills.
Lawrence	Walter E. Parker	Pacific Mills.
Lawrence	Robert Redford	Box 28.
Lawrence	Francis H. Silsbee	Pacific Mills.
Lawrence	Walter H. Summersby	Atlantic Cotton Mills.
Lawrence	William D. Twiss	Everett Mills.
Lawrence	William S. Whitney	American Woolen Co.
Leicester	Charles A. Denny	American Card Clothing Co.
Linwood	Amos G. Maddox	Linwood Mill.
Linwood	Fred B. Whitin	Uxbridge Cotton Mills.
Lowell	George E. Ames	Lawrence Manufg. Co.
Lowell	Frank A. Bowen	Appleton Co.
Lowell	Edward N. Burke	Lowell Machine Shop.
Lowell	W. W. Carey	Wood Rim Pulleys and Wood Working Machinery.
Lowell	John J. Connell	Tremont and Suffolk Mills.
Lowell	Clarence N. Childs	Hamilton Mfg. Co.
Lowell	Richard Cowell	Boott Cotton Mills.
Lowell	A. G. Cumnock	Appleton Co.
Lowell	Joseph L. Cushing	Daniel Cushing & Co.
Lowell	Albert W. Danforth	Shanghai Cotton Cloth Mills.
Lowell	Albert Deabill	Lowell Hosiery Co.
Lowell	Edward P. Dennis	Lowell Machine Shop.
Lowell	William Ambrose Eastman	Lowell Hosiery Co.
Lowell	T. C. Entwistle	T. C. Entwistle Co.
Lowell	Royal W. Gates	Josiah Gates & Sons.
Lowell	Sumner S. Gould	Lowell Branch Am. Card Clo. Co.
Lowell	William E. Hall	Shaw Stocking Co.
Lowell	Otis L. Humphrey	Cotton Dept. Lowell Textile School.

Lowell	A. W. Hunking,	374 Stevens St.
Lowell	Frank B. Kenney	Kitson Machine Co.
Lowell	Charles F. Libby	Shaw Stocking Co.
Lowell	Alvin S. Lyon	Bigelow Co.
Lowell	Albert H. Morton	Kitson Machine Co.
Lowell	Oliver H. Moulton	Hamilton Manufg. Co.
Lowell	Franklin Nourse	Lawrence Manufg. Co.
Lowell	John W. Pead	Merrimack Manufg. Co.
Lowell	Haven C. Perham	Kitson Machine Co.
Lowell	M. A. Rawlinson	Tremont & Suffolk Mills.
Lowell	Edwin A. Robinson	Tremont and Suffolk Mills.
Lowell	William S. Southworth	Mass. Cotton Mills.
Lowell	Ariel C. Thomas	Boott Cotton Mills.
Lowell	Charles T. Upton	63 Mt. Vernon St.
Lowell	Jude C. Wadleigh	Mass. Cotton Mills.
Lowell	Walter S. Watson	Haworth & Watson.
Lowell	Channing Whitaker	Lowell Machine Shop.
Lynn	Henry B. Sprague	Boston Woven Hose and Rubber Co.
Lynn	C. J. H. Woodbury	61 Commercial St.
Medford	Henry B. Ashton	S. A. Felton & Son Co.
Methuen	Lewis E. Barnes	Pemberton Co. and Methuen Co.
Methuen	Alfred Sagar	Arlington Cotton Mills.
Millbury	Fred W. Moore	Cordis Mills.
Millbury	Francis H. Rice	Holbrook Mfg. Co.
Millbury	Henry M. Wilcox	John Rhodes Warp Co.
Millbury	Eben C. Willey	Holbrook Mfg. Co.
New Bedford	Christopher P. Brooks	New Bedford Textile School.
New Bedford	Byron F. Card	
New Bedford	William W. Crapo	Wamsutta Mills.
New Bedford	Frederick Grinnell	Gen. Fire Extinguisher Co.
New Bedford	Henry A. Holcomb	Box 249.
New Bedford	Nathaniel B. Kerr	Butler Mill.
New Bedford	Walter H. Langshaw	Dartmouth Manufg. Corp.
New Bedford	Stephen C. Lowe	John Hetherington & Sons, Ltd.
New Bedford	Frederick B. Macy	Soule Mills.
New Bedford	John McCullough	Cotton Waste Merchant.
New Bedford	John Neild	Grinnell Mfg. Co.
New Bedford	Albert R. Pierce	Pierce Mfg. Corporation.
New Bedford	Andrew G. Pierce, Jr.	Pierce Mfg. Corp.
New Bedford	Frederick W. Reynolds	Potomska Mills.
New Bedford	James O. Thompson, Jr.	Wamsutta Mills.
New Bedford	Herbert E. Walmsley	Wamsutta Mills.
New Bedford	Lettice R. Washburn	235 North Water St.
New Bedford	William R. West	830 Purchase St.
New Bedford	Benjamin Wilcox	City and Bristol Mfg. Co.
Newton	Josiah G. Coburn	99 Washington St.
Newtonville	Oscar B. Truesdell	18 Washington Terrace.
Newton Upper Falls	Frank J. Hale	Saco and Pettee Machine Shops.

Newton Upper Falls	R. Paul Snelling	Saco and Pettee Machine Shops.
North Adams	Hervey Burnham	Beaver Mills and Eclipse Mill.
North Adams	Charles W. Dennett	Johnson-Dunbar Mills Co.
North Adams	Henry C. Phillips	Greylock Mills.
Northbridge	Henry S. Houghton, Jr.	Paul Whitin Manufg. Co.
Northbridge	Henry T. Whitin	Paul Whitin Manufg. Co.
North Oxford	Edwin N. Bartlett	Sigourney and Rockdale Mills.
North Plymouth	Gideon F. Holmes	Plymouth Cordage Co.
Pittsfield	Henry D. Martin	J. L. and T. D. Peck Mfg. Co.
Readville	William N. Shaw	George W. Stafford Co.
Readville	George W. Stafford	George W. Stafford Co.
Readville	H. E. Stafford	George W. Stafford Co.
Salem	C. F. Curwen	Dinsmore Mfg. Co.
Salem	William P. McMullan	Naumkeag Steam Cotton Co.
Salem	Henry Osgood	P. O. Box 204.
Salem	Nathaniel G. Simonds	Naumkeag Steam Cotton Co.
Shattuckville	Frank S. Field	Massaemit Yarn Mills.
South Hadley Falls	William R. Hill	Glasgow Manufg. Co.
Springfield	Joseph M. Dunham	43 Edwards St.
Springfield	Nelson Whittier	Whittier Mills.
Taunton	A. C. Bent	Safety Seamless Pocket Co.
Taunton	William H. Bent	Mason Machine Works.
Taunton	Peter H. Corr	Greenwich Bleachery.
Taunton	Thomas G. Cox	Mason Machine Works.
Taunton	P. T. Creed	Hopewell Mills.
Taunton	H. H. Culver	Elizabeth Poole Mills.
Taunton	Henry S. Culver	Westville Cotton Mills.
Taunton	Andrew J. Currier	Cohannet and Nemasket Mills.
Taunton	Herbert Fisher	
Taunton	Jesse A. Knight	Cohannet Mills.
Taunton	Henry M. Lovering	Whittenton Manufg. Co.
Taunton	William M. Lovering	Whittenton Manufg. Co.
Taunton	Charles L. Macomber	Winthrop Cotton Yarn Co.
Taunton	John Tempest Meats	Mason Machine Works.
Taunton	Herbert H. Shumway	Corr Manufg. Co.
Taunton	James W. Taylor	Canoe River Mills.
Taunton	Joseph S. Tidd	Oakland Mills.
Thorndike	Charles H. Hobbs	Thorndike Co.
Three Rivers	Roscius C. Newell	Palmer Mill.
Turners Falls	Samuel L. Parker	Turners Falls Cotton Mills.
Walnut Hill	Benjamin M. Earle	Merchants Dye Works.
Waltham	Charles E. Getchell	Waltham Bleachery & Dye Works.
Waltham	Arthur H. Gulliver	Boston Mfg. Co.
Ware	George E. Tucker	The Otis Co.
Webster	E. P. Morton	Stevens Linen Works.
West Warren	George A. Moody	West Warren Cotton Mills.

Whitinsville	Alfred E. Adams	Whitinsville Cotton Mills and Linwood Mills.
Whitinsville	Lawrence M. Keeler	Whitin Machine Works.
Whitinsville	Josiah M. Lasell	Whitin Machine Works.
Whitinsville	Oscar L. Owen	Whitin Machine Works.
Whitinsville	Cyrus A. Taft	Whitin Machine Works.
Whitinsville	Arthur F. Whitin	Saunders Cotton Mills.
Whitinsville	G. Marston Whitin	Whitin Machine Works.
Williamstown Sta.	Roland R. Kelly	Williamstown Manufg. Co.
Winchester	George H. Sayward	
Worcester	Joseph P. Battles	Crompton & Knowles Loom Works.
Worcester	George Crompton	
Worcester	Henry F. Harris	W. Boylston Mfg. Co.
Worcester	Lewis T. Houghton	997 Main St.
Worcester	A. H. Howard	Howard Bros. Mfg. Co.
Worcester	C. H. Hutchins	Crompton & Knowles Loom Works.
Worcester	Geo. I. Rockwood	62 Summer St.
Worcester	John M. Russell	Crompton & Knowles Loom Works.
Worcester	Justin A. Ware	Crompton & Knowles Loom Works.
Worcester	J. F. Warren	J. F. & W. H. Warren Co.
Worcester	W. W. White	Holyoke Machine Co.
Worcester	Alfred N. Whiting	L. M. Harris Mfg. Co.

RHODE ISLAND.

Allenton	R. A. Gray	Rodman Manufg. Co.
Ashton	Charles H. Collins	Berkeley Co.
Ashton	Robert Stewart	Lonsdale Co.
Bayside	Abel T. Atherton	Machine Maker.
Central Falls	Louis B. Barker	United States Cotton Co.
Central Falls	David Grove	United States Cotton Co.
Central Falls,	B. F. G. Linnell,	Yarns, Threads and Twines.
Centreville	James T. Ferguson	Warwick Mills.
Centreville	Robert B. Treat	Centreville Cotton Mills.
Crompton	Charles D. Robinson	Crompton Co.
Davisville	Walter B. Knight	Reynolds Manufg. Co.
Fiskville	James Gee	Interlaken Dye Works.
Forestdale	Alphonso F. White	Forestdale Mfg. Co.
Hamilton	Joseph Warren Greene	Hamilton Web Co.
Lonsdale	Edward A. Mongeon	Lonsdale Mills.
Manville	A. Tenny White	Manville Co.
Natick	Charles M. Holmes	Natick Mills.
Pawtucket	William W. Blades	Lorraine Mfg. Co.
Pawtucket	Robert Burgess	Slater Cotton Co.
Pawtucket	William P. Dempsey	Dempsey Bleachery & Dye Works.
Pawtucket	Henry C. Dexter	Greene & Daniels Mfg. Co.
Pawtucket	Fred W. Easton	Easton & Burnham Machine Co.

Pawtucket	D. A. Everly	Cotton Mfr.
Pawtucket	William H. Greene	Greene & Daniels Mfg. Co.
Pawtucket	John J. Hart	Charlton Manufg. Co.
Pawtucket	David Jackson	Jackson Pat. Shell Roll Co.
Pawtucket	J. E. Jenckes	The E. Jenckes Manufg. Co.
Pawtucket	James R. MacColl	Lorraine Manufg. Co.
Pawtucket	E. R. Richardson	Howard & Bullough American Machine Co., Ltd.
Pawtucket	Dwight Seabury	12 East Ave.
Pawtucket	S. Willard Thayer	Dexter Yarn Co.
Pawtucket	Fred A. Wilde	A. T. Atherton Machine Co.
Peace Dale	William C. Greene	Peace Dale Manufg. Co.
Phenix	Henry R. Brown	Phenix Mill.
Pontiac	Walter B. Hall	Pontiac Mill, B. B. and R. Knight.
Providence	Charles T. Aldrich	Aldrich Manufg. Co.
Providence	William Ames	Fletcher Mfg. Co.
Providence	H. C. Atwood	Williamsville Manufg. Co.
Providence	George R. Babbitt	American Oil Co.
Providence	Edward R. Ballou	Ballou Yarn Co.
Providence	Truman Beckwith	Dyerville Manufg. Co.
Providence	J. Frank Braids	Charles S. Bush Co.
Providence	D. Russell Brown	Brown Bros. Co.
Providence	H. Martin Brown	U. S. Bobbin & Shuttle Co.
Providence	E. C. Bucklin	Interlaken Mills.
Providence	Fred N. Bushnell	Narragansett Electric Light Co.
Providence	Albert L. Calder, 2nd	P. O. Box 206.
Providence	Charles H. Child	Standard Mill Supply Co.
Providence	Frederick I. Dana	Thomas Phillips Co.
Providence	A. Lockwood Danielson	Quinebaug Co.
Providence	J. DeForest Danielson	Lockwood Co. and Lewiston Bleachery and Dye Works.
Providence	John W. Danielson	Lockwood Co. and Ponemah Mills.
Providence	E. W. Davenport	Crompton & Knowles Loom Works.
Providence	F. C. Fletcher	Lawton Spinning Co.
Providence	J. Herbert Foster	10 South Water St.
Providence	William Gammell	Berkeley Co.
Providence	Rufus B. Goff	Standard Mill Supply Co.
Providence	William S. Granger	Granger Foundry & Machine Co.
Providence	Henry T. Grant, Jr.	Mercantile Mutual Fire Insurance Co.
Providence	John H. Hambly	Quidnick Mfg. Co.
Providence	A. Walter Harris	A. W. Harris Oil Co.
Providence	Elisha H. Howard	Cotton Goods Broker.
Providence	Frederic W. Howe	Crompton & Knowles Loom Works.
Providence	Daniel Jackson	B. B. & R. Knight.
Providence	John E. Kendrick	American Supply Co.
Providence	Stephen A. Knight	Hebron Manufg. Co.
Providence	Webster Knight	B. B. & R. Knight's Mills.

Providence	W. C. Langford	86 Weybosset St.
Providence	Charles Warren Lippitt	Silver Spring B. & D. Co.
Providence	Henry F. Lippitt	Social and Manville Cos.
Providence	Charles R. Makepeace	Box 973.
Providence	A. T. Malcolmson	C. Bischoff & Co.
Providence	F. H. Maynard	Gen. Fire Extinguisher Co.
Providence	Thomas Mayor	Thomas Mayor & Son.
Providence	Charles H. Merriman, Jr.	Social Mfg. Co.
Providence	William C. Peirce	Elizabeth Mill.
Providence	Reuben Pilling, Jr.	30 Hudson St.
Providence	Stephen Minot Pitman	Narragansett Mutual Fire Ins. Co.
Providence	Charles A. M. Praray	Chas. A. M. Praray & Co.
Providence	Peleg A. Rhodes	P. O. Box 315.
Providence	Richard H. Rice	Providence Engineering Works.
Providence	Walter Rigby	Ballou Yarn Converting Co.
Providence	George W. Robbins	Dyerville Mfg. Co.
Providence	Louis E. Robinson	36 So. Water St.
Providence	Richard W. B. Sanderson	G. S. Lings & Co.
Providence	F. C. Sayles	Baltic Mills Co.
Providence	Frank P. Sheldon	Industrial Trust Building.
Providence	Harry M. Smith	Standard Mill Supply Co.
Providence	Wilton H. Spencer	7 Exchange Place.
Providence	Daniel J. Sully	T. M. Reynolds & Co.
Providence	Robert Rennie Taft	P. O. Box 1443.
Providence	Robert W. Taft	Coventry Co.
Providence	Charles F. Taylor	21 Eddy St.
Providence	D. M. Thompson	B. B. & R. Knight's Mills.
Providence	James T. Thornton	A. B. Pitkin Machinery Co.
Providence	H. A. Tillinghast	Granger Foundry & Machine Co.
Providence	A. Curtis Tingley	National Ring Traveler Co.
Providence	W. O. Todd	Lawton Spinning Co.
Providence	William P. Vaughan	Putnam Mfg. Co.
Riverpoint	Arthur F. Brackett	Royal Arctic and Valley Queen Mills.
Riverpoint	C. Prescott Knight	B. B. & R. Knight's Mills.
Valley Falls	Edward B. Jennings	Samoset Co.
Valley Falls	John W. Ramsbottom	Samoset Co.
Warren	E. A. Rusden	Rusden Machine Co.
Warren	Arnold Schaer	Warren Manufg. Co.
Westerly	Robert Dow	Solway Mills.
Westerly	A. E. Henry	Solway Mills.
Westerly	Louis L. Hohn	122 High St.
Woonsocket	Malcolm Campbell	Woonsocket Mach. & Press Co.
Woonsocket	Harry K. Drew	Clinton Mfg. Co.
Woonsocket	William Halliwell	Providence and Woonsocket Mills of the Lawton Spinning Co.
Woonsocket	Edward W. Houghton	Globe Mill.
Woonsocket	Henry S. Houghton, Sr.	61 Pond St.

Woonsocket	Albert C. Hoy	Hamlet Mills.
Woonsocket	William N. Kimball	Social and Nourse Mills.
Woonsocket	Albert F. Knight	39 Main Street.
Woonsocket	Robert G. McMeehan	Hamlet Textile Co.
Woonsocket	William A. Robinson	Manville Co.
Woonsocket	Earl A. Thissell	Woonsocket Bobbin Co.
Woonsocket	Charles E. Thomas	Forestdale Mfg. Co.

CONNECTICUT.

Baltic	Harold Lawton	Baltic Mills Co.
Danielson	James Herbert Smith	Quinebaug Co.
Hartford	William H. Stratton	Factory Insurance Association.
Jewett City	James O. Sweet	Ashland Cotton Co.
Jewett City	Adelbert R. Young	Ashland Cotton Co.
Killingly	W. E. Atwood	Williamsville Manufg. Co.
Killingly	C. H. Truesdell	Attawaugan Co.
Middletown	J. F. Powers	Spinning Mill.
Montville	Emory S. Rathbun	Pequot Mills.
Moosup	William J. Cray	Aldrich Mfg. Co.
New Haven	George S. Barnum	The Bigelow Co.
Norwich	W. N. Blackstone	Attawaugan Co. and Totokett Mills Co.
Norwich	W. R. Burnham	
Norwich	C. H. Frisbie	Attawaugan Co.
Norwich	W. G. Henderson	Shetucket Co.
Norwich	John F. Reardon	Falls Co.
Norwich	Charles D. White	Uncasville Manufg. Co.
Putnam	George W. Holt	Monohansett Manufg. Co.
Putnam	George A. Vaughan	Putnam Manufg. Co.
Taftville	Joseph D. Aiken	Ponemah Mills.
Taftville	John Eccles	Ponemah Mills.
Voluntown	George T. Briggs	The Briggs Mfg. Co.
Wauregan	James A. Atwood	Wauregan Co. & Quinebaug Co.
Wauregan	John Walter Atwood	Wauregan Co.
Willimantic	Dickerson G. Baker	American Thread Co.
Willimantic	E. S. Boss	Willimantic Linen Co.
Willimantic	Joseph Mercer	Willimantic Cotton Mills Co.
Windsor Locks	J. R. Montgomery	The J. R. Montgomery Co.

NEW YORK.

Capron	W. H. Cloher, Jr.	Utica Cotton Co.
Chadwicks	Bradford C. Divine	Utica Willowvale Bleaching Co.
Cohoes	David S. Johnston	Cohoes Iron Foundry & Machine Co.
Cohoes	George E. Prest	No. 1 Harmony Mill.

Cohoes	Harry B. Prest	Harmony Mills.
Cohoes	John E. Prest	Harmony Mills.
Cohoes	William H. Robinson	No. 3 Harmony Mill.
Cohoes	Albion K. Searls	Ogden Mill (Harmony Mills).
Elmira	William H. Bilbrough	Elmira Knitting Mills and Conewawah Spinning Co.
Jamestown	Thomes Henry Smith	Jamestown Cotton Mill.
Newburgh	William J. Hadfield	Newburgh Steam Mills.
New York City	George Arms	Grand Hotel.
New York City	Edwin H. Baker	Bliss, Fabyan & Co.
New York City	D. C. Ball	27 William St.
New York City	Percy H. Brundage	49 Wall St.
New York City	Albert C. Case	American Cotton Co.
New York City	J. E. Cheesman	Cheesman Cotton Gin Co.
New York City	Arthur C. Freeman	Rusden Machine Co.
New York City	Ernest L. Hill	Renfrew Mfg. Co.
New York City	Arthur B. Mann	J. H. Martin & Co.
New York City	Arthur Parkinson	Arabol Mfg. Co.
New York City	Duncan D. Parmly	Johnson Mfg. Co. & Dunbar Mills Co.
New York City	Vladimir P. Polevoy	Jaroslav Cotton Mills.
New York City	George A. Wies	Eureka Fire Hose Co.
New York Mills, Oneida Co.,	John P. Campbell,	New York Mills.
Syracuse	Sanford E. Loring	104 Everson Building.
Upper Troy	A. G. Harris	W. H. Draper & Son.
Utica	George DeForest	Utica Steam Cotton Mills.
Utica	George E. Farrell	Utica Spinning Co.
Utica	D. W. Gray	Skenandoa Cotton Co.
Utica	Henry F. Mansfield	Utica Steam Cotton Mills and Mohawk Valley Cotton Mills.
Utica	John B. Wild	Oneita Knitting Mills.

NEW JERSEY.

Gloucester	Philip H. Fowler	417 Monmouth St.
Gloucester	George W. Turner	Argo Mills Co.
Jersey City	Ernest Bridge	Jas. Chadwick & Bro. Ltd.
Jersey City	Maxwell Grierson	Jas. Chadwick & Bro., Ltd.
Jersey City	B. L. Stowe	Eureka Fire Hose Co.
Millville	C. Enos Bean	Millville Mfg. Co.
Millville	A. W. Brainerd	May's Landing Water Power Co. and Millville Mfg. Co.
Newark	William H. Loftus	Clark Thread Co.
New Brunswick	William Henry Hobbs	Johnson & Johnson Co.
New Brunswick	William H. Ritter	Johnson & Johnson.
Passaic	Dudley T. Lyall	Brighton Mills.
Passaic	William L. Lyall	Brighton Mills.
Paterson	John W. Ferguson	Paterson Nat. Bank Bldg.

PENNSYLVANIA.

Chester	W. T. Galey	Aberfoyle Manufg. Co.
Chester	D. Edwin Irving	The Irving & Leiper Manufg. Co.
Mt. Joy	Thomas J. Brown	George Brown's Sons.
Philadelphia	Robert Beatty	Coral and Adams Sts.
Philadelphia	T. Ashby Blythe	Ashby Cotton Mills.
Philadelphia	Alfred H. Burnham	Glasgow Mills.
Philadelphia	Harry W. Butterworth	H. W. Butterworth & Sons.
Philadelphia	James Butterworth	H. W. Butterworth & Sons.
Philadelphia	Frederick A. Downes	Factory Mutual Fire Insurance Cos.
Philadelphia	Edward W. France	Philadelphia Textile School.
Philadelphia	Merrill A. Furbush	2015 North 33rd St.
Philadelphia	Joshua Garsed	Wingohocking Mills and National Spinning Co., Frankford.
Philadelphia	Otto Goetze	Glasgow Mills.
Philadelphia	John T. Greenwood	R. Greenwood & Bault.
Philadelphia	Henry S. Grove	Argo Mills Co.
Philadelphia	W. C. Houston	Hope Mills Mfg. Co.
Philadelphia	John H. Lorimer	Ontario and Lawrence Sts.
Philadelphia	David Milne	Washington Ave. and 11th St.
Philadelphia	John R. Mitchell	Mitchell-Bissell Co.
Philadelphia	John K. Russell	3003 West York St.
Philadelphia	Edward H. Sanborn	Cold Spring Bleach. & Fin. Works.
Philadelphia	Theodore C. Search	Cold Spring Bleach. & Fin. Works.
Philadelphia	William E. Winchester	Philadelphia Textile School.
Philadelphia	George Wood	Millville Mfg. Co.
Philadelphia	John P. Wood	Spring Garden and 22nd Sts.
Philadelphia	Oscar W. Wood	Germantown Spinning Co.

DELAWARE.

Wilmington	William P. Bancroft	Joseph Bancroft & Sons Co.
Wilmington	Daniel Moore Bates	Joseph Bancroft & Sons Co.
Wilmington	Colin C. Bell	American Vulcanized Fibre Co.

MARYLAND.

Baltimore	James A. Gary	Alberton Mills.
Baltimore	Charles K. Oliver	Mt. Vernon-Woodberry Cot. Duck Co.
Ilchester	Samuel F. Patterson	Thistle Mills Co.

VIRGINIA.

Lynchburg	Theop. W. Wilmarth	1205 Floyd St.

NORTH CAROLINA.

Asheville	William Whittam, Jr.	The William Whittam Textile Co.
Charlotte	S. B. Alexander, Jr.	S. B. Alexander, Jr., Co.
Charlotte	Henry C. Clark	Charlotte Supply Co.

Charlotte	R. M. Miller, Jr.	Elizabeth Mills.
Charlotte	Daniel A. Tompkins	Atherton Mills.
Durham	O. W. Stites	Commonwealth Cotton Mfg. Co.
Fayetteville	Walter L. Holt	Holt-Morgan Mills.
Greensboro	Caesar Cone	Proximity Mfg. Co.
Greensboro	Edward T. Garsed	Hucomuga Mills.
Hope Mills	Frank H. Cotton	Hope Mills Mfg. Co.
Kings Mountain	F. Dilling	Dilling Cotton Mills.
Lincolnton	R. S. Reinhardt	Elm Grove Cotton Mills.
Mountain Island	W. T. Jordan	Mt. Island Manufg. Co.
West Durham	Edward W. Thomas	Erwin, Pearl, Durham, Alpine and Cooleemee Cotton Mills.
Winston-Salem	John W. Fries	F. & H. Fries.

SOUTH CAROLINA.

Chester	William G. Nichols	Springstein Mills.
Columbia	James Sumter Moore	Olympia & Richland Cotton Mills.
Columbia	W. H. Rose	Granby Cotton Mills.
Columbia	W. B. Smith Whaley	Richland & Granby Cotton Mills.
Fort Mill	Farquharson J. Muir	Fort Mill Mfg. Co. & Millfort Mill Co.
Gaffney	H. D. Wheat	Gaffney Mfg. Co. and Orient Mfg. Co.
Graniteville	T. H. Rennie	Graniteville Mfg. Co.
Greenville	James R. Pearce	Monaghan Mills.
Lancaster	Leroy Springs	Lancaster Cotton Mills.
Langley	Arthur T. Smith	Langley Manufg. Co. and Aiken Manufg. Co.
Laurens	O. B. Parker	Laurens Cotton Mills.
Newbury	Edward B. Wilbur	Mollohon Mfg. Co.
Pelham	D. G. Sunderland	The Pelham Mills.
Pelzer	B. F. Guy	Pelzer Manufg. Co.
Pelzer	Ellison A. Smyth	Pelzer Manufg. Co.
Union	T. C. Duncan	Union Cotton Mills.

GEORGIA.

Aragon	D. E. McGaw	Aragon Mills.
Atlanta	Samuel A. Carter	Gate City Cotton Mills.
Atlanta	C. E. W. Dow	Am. Moist. Co. and Wm. Firth Co.
Atlanta	W. L. Draper	Dodge Mfg. Co.
Atlanta	Oscar Elsas	Fulton Bag and Cotton Mills.
Atlanta	Henry E. Fisher	Atlanta Cotton Mills.
Atlanta	Harry W. Kimball	Fulton Bag and Cotton Mills.
Atlanta	William M. Nixon	Atlanta Woolen Mills.
Augusta	Thomas Barrett, Jr.	Langley & Aiken Mills.
Augusta	John W. Chafee	The Sibley Mfg. Co.
Augusta	T. I. Hickman	Graniteville Mfg. Co.
Augusta	Otis G. Lynch	Enterprise Manufg. Co.

Augusta	Joel Smith	J. P. King Mfg. Co.
Augusta	George R. Stearns	Riverside Mills.
Augusta	Eugene F. Verdery	Warren Mfg. Co.
Augusta	James P. Verdery	Enterprise Mfg. Co.
Chattahoochee	W. R. B. Whittier	Whittier Mills.
Columbus	E. N. Clemence	Eagle & Phenix Mills.
Columbus	Frederick B. Gordon	Columbus Mfg. Co.
Columbus	Charles H. Gorton	Columbus Mfg. Co.
Columbus	George W. Towne	Columbus Power Co.
East Point	Edward C. Beach	Gate City Cotton Mills.
Griffin, Spalding Co.	Albert G. Martin	Kincaid Manufg. Co.
Gainesville	J. Colby Lewis	Vesta Cotton Mills.
Lindale	Henry P. Meikleham	Mass. Mills in Georgia.
Macon	W. H. Richmond	Bibb Mill No. 2.
Macon	Broadus E. Willingham	Willingham Cotton Mills.
West Point	Scott Maxwell	Lanett Cotton Mills.

TENNESSEE.

Knoxville	William T. Lang	Brookside Mills.
Memphis	C. C. Cowan	372 Front St.
Memphis	Jerome Hill	Jerome Hill Cotton Co.
Nashville	T. B. Dallas	Dallas Mfg. Company.

ILLINOIS.

Chicago	Frederick A. Flather	McCormick Harvesting Machine Co.

MISSISSIPPI.

Agricultural College,	Arthur Whittam	Miss. Agricultural and Mechanical College.

LOUISIANA.

New Orleans	S. Odenheimer	Lane Mills.

KENTUCKY.

Henderson	Paul J. Marrs	Henderson Cotton Mills.
Louisville	Philip S. Tuley	Louisville Cotton Mills Co.

ALABAMA.

Birmingham	B. B. Comer	Avondale Cotton Mills.
Cordova	Joseph O. Hannum	Indian Head Mills of Ala.
Huntsville	T. W. Pratt	West Huntsville Cotton Mill Co.
Langdale	Charles M. Sears	West Point Mfg. Co.

TEXAS.

Galveston	Lawrence V. Elder	Galveston City Cotton Mills.

CANADA.

Province of Ontario.

Cornwall	S. Greenwood	The Canadian Colored Cotton Mills Co. Ltd.
Hamilton,	Charles Owen Dexter	The Canadian Colored Cotton Mills Co., Ltd.
Hamilton,	James M. Young	Hamilton Cotton Co.
Ottawa	Louis Simpson	Victoria Chambers.

Province of Quebec.

Hochelaga	W. S. Hume	176 Notre Dame St.
Montreal	Alfred Hawkesworth	Merchants Cotton Co.
Montreal	Fred Hawkesworth	Merchants Cotton Co.
Montreal	D. K. McLaren	751 Craig St.
Montreal	A. B. Mole	Dominion Cotton Mills Co.
Valleyfield	Ernest E. Clark	Montreal Cotton Co.
Valleyfield	Fred Lacey	Montreal Cotton Co.
Valleyfield	Charles H. Potter	Montreal Cotton Co.

NEW BRUNSWICK.

Milltown	Lewis Dexter, Jr.	The Canadian Colored Cotton Mills Co., Ltd.
St. John	John B. Cudlip	Cornwall and York Cotton Mills Co.
St. John	John H. Parks	John H. Parks & Co.

ENGLAND.

Matlock, Derbyshire,	John Edward Lawton	American Thread Co.
Huddersfield	John Sykes	English Card Clothing Co.

RECAPITULATION.

LOCATION OF MEMBERSHIP.

Maine	19
New Hampshire	32
Vermont	1
Massachusetts	313
Rhode Island	120
Connecticut	28
New York	32
New Jersey	13
Pennsylvania	26
Delaware	3
Maryland	3
Virginia	1
North Carolina	15
South Carolina	16
Georgia	28
Tennessee	4
Illinois	1
Mississippi	1
Louisiana	1
Kentucky	2
Alabama	4
Texas	1
Province of Ontario	4
Province of Quebec	8
New Brunswick	3
England	2
	681

IN MEMORIAM.

SHELDON S. SPENCER.

SHELDON S. SPENCER was born in Hartford, Conn., Sept. 15, 1825. He was of English descent and inherited the love of agricultural life of his ancestors and took recreation in his farm and also in the encouragement of better methods of farming through the agricultural societies with which he was connected. After an academy education, he entered a cotton mill at Chicopee, Mass., and also continued his studies during winters, when he left the service of the mill for such purposes. When he was 21 he became assistant overseer in the Conestoga Steam Mills at Lancaster, Pa., finally becoming general superintendent, which position he held the rest of his life. He had a thorough knowledge of cotton manufacturing and was progressive in the adoption of the best machinery and methods. He took an active interest in everything pertaining to the good of his help, establishing a night school, a Mutual Benefit Association and a systematic method of providing medical service for those who were ill or injured. In the city of Lancaster he was a public spirited citizen and did much toward the improvement of highways and the better administration of affairs. He was connected with the Moravian Church and took great interest in the religious and literary development of the community. He was a man of great intellectual force which had become largely developed by wide reading and careful observation. He married a daughter

of JACOB BERTZ in 1851, who died a few years later. He died Nov. 11, 1901, and is survived by a widow of a second marriage, a daughter of JACOB FOLTZ. He became a member of the Association Oct. 25, 1876 and was a constant attendant at the meetings, enjoying the companionship of the members for which his congenial nature and love of humanity rendered him a most agreeable associate.

HERBERT H. FARNUM.

HERBERT R. FARNUM died at his home in Georgiaville, R. I., Dec. 13, 1901, after a short illness. He was born in Georgiaville in 1853, entered the Bernon Mfg. Co. mill when a boy, afterwards becoming its bookkeeper and later its superintendent. He was an active member of the Free Will Baptist Church and one of the leading laymen of that denomination in the state. He left a widow and six children. He became a member of the Association April 27, 1881.

ALBERT KNIGHT.

ALBERT KNIGHT, for many years superintendent of the cotton mills belonging to the Quidnick Manufacturing Company, died at his home in Quidnick, R. I., Feb. 9, 1902.

He was born in West Greenwich, R. I., June 21, 1834; was educated in the public schools of the town; entered the employment of the cotton mill at Washington, R. I., and learned the cotton manufacturing business by being employed in nearly every department of a cotton mill, as operative, overseer and superintendent. In the latter capacity he has been for years

well known as manager of extensive mills in Connecticut, Massachusetts and Rhode Island. He was a Mason, being a member St. Alban's Lodge, Bristol, R. I., and the Chapter at Phenix, R. I.

He became a member of the New England Cotton Manufacturers' Association April 24, 1895, and was well known throughout the country in cotton manufacturing circles. For the past six years he had been an invalid, much of the time being confined to the house. He is survived by his three sons Albert F., Edward I. and Walter B., all of whom are also well known cotton manufacturers.

JOSEPH WARREN WATTLES.

JOSEPH WARREN WATTLES died of pneumonia at his home in Canton, Mass., Feb. 13, 1902. He was born Dec. 16, 1824, and his connection with cotton manufacturing began as a bobbin boy in a cotton mill at Norwich, Conn. At the age of 21 he came to Canton and became superintendent of the Neponset Cotton Mills there, and was later manager of the Ocean Mills at Newburyport, Mass. Before going to Newburyport, he established a business at Canton for the manufacture of spindles and spinning rings, with which he has always maintained a connection and he was also engaged in the manufacture of sizing compounds for both cotton and woolen warps. He was married in January, 1851, to Miss FANNIE D. MARTIN, who died in 1896, and he left two sons and a daughter. He was a man of strong character and robust physique which furnished him with an energy which sustained his vigorous mind throughout his many years of life. He became a member of the Association July 18, 1866, and at the meeting on April 30, 1884, gave a statement of the organization of the English system of picking and carding which he had adopted at the Ocean Mills.

WILLIAM ALVORD BURKE.

WILLIAM ALVORD BURKE* was born in Windsor, Vt., July 7, 1811, and died at Lowell, Mass., May 28, 1887. He was the son of BENJAMIN and ROXANA (ALVORD) BURKE, who was the son of SOLOMON and KEZIAH (BENJAMIN) BURKE, who was the son of JONATHAN and THANKFUL (WAIT) BURKE, who was the son of RICHARD and AGIGAIL (SAWTELL) BURKE, who was the son of RICHARD and MARY (PARMENTER) BURKE, who died at Sudbury, Mass., in the year 1693-4.

His early education was obtained at the Academy of JOSIAH DUNHAM, Esq., at Windsor, Vt., and with a view to a collegiate education, but circumstances not favoring such a course, upon the removal of his parents to Nashua, N. H., at the age of fifteen he entered the machine shop of the Nashua Mfg. Co. as an apprentice. He worked faithfully at his trade for several years in this shop, also in the shops of the Locks and Canals in Lowell, Mass. (now the Lowell Machine Shop) for a short time until January, 1834, when he had charge of the machine shop of Ira Gay & Co., of Nashua, N. H., for two years. This was a very important period for Mr. BURKE, as he here began the oversight and charge of men, which was of great benefit to him later. In the spring of 1836, he was called to the machine shop of the Boott Cotton Mills, Lowell, Mass., as a master mechanic, where he remained for three years, when he resigned to become the master mechanic of the machine shop of the Amoskeag Mfg. Co., of Manchester, N. H., which had just been erected. He put into successful operation and had charge and direction of these works for six years. These years were of great profit and benefit to him, as it necessitated his designing and building

* This sketch of the able and active career of one who had taken such a strong part in matters leading to the present development of cotton manufacture recently came into possession of the Association, and its publication was considered desirable even at this late day. — *Secretary.*

cotton machinery, which afterwards became a chief occupation of his life. At this time it was impossible to obtain any machinery from England, and he was, therefore, left to his own resources, or to the very few and crude drawings obtained elsewhere.

In 1845 the shops of the Locks and Canals in Lowell, Mass., were sold to a corporation, now known as the Lowell Machine Shop, and Mr. BURKE was invited by those who knew his worth to take charge and develop this establishment. This he did and remained as their agent and superintendent for 17 years. During this time the shops made everything from a sewing machine needle to a locomotive and increased five-fold in size, but their principal business then (as it is altogether now) was the building of cotton machinery.

In 1862 he became agent of the Boott Cotton Mills of Lowell, Mass. At this time on account of the Civil War the cotton mills generally were at a very low ebb, and the Boott Cotton Mills especially, owing to local causes, were in bad shape. He remained with these mills for six years, during which time he placed the corporation on a firm and satisfactory basis and made a paying mill of it. His success as agent of the Boott Cotton Mills attracted the attention of mill men, and in 1868, he was offered and accepted the treasurership of the Suffolk Mfg. Co. and of the Tremont Mills (now known as the Tremont and Suffolk Mills). There he remained for two years, but circumstances not being congenial, he resigned in 1870, and shortly after he was appointed assistant treasurer of the Great Falls Mfg. Co. of Somersworth (then Great Falls), N. H., and the Dwight Mfg. Co. of Chicopee, Mass. He remained there for six years, advising and supervising the renovation and rebuilding of these mills, placing them in the condition where they afterwards became great successes. Owing to the business failure of the treasurer, he was obliged to relinquish the assistant treasurership of these companies, but in 1876 he became the treasurer of the Lowell Machine Shop, where he had been its first superintendent. Here he remained until declining years

advised him that his work as an active business men was over, and he resigned in 1885.

He early appreciated the difficulties that many young men encountered in life, especially in providing for their families. It was owing to this that he, in 1861, with others, began the agitation of a savings bank, to enable the mechanic and wage earner to hoard up their earnings, instead of squandering them, as many did. He was one of the original corporators of the Mechanics Savings Bank of Lowell, Mass., and its first president, from June, 1861, to June, 1886, when he retired. Owing to his varied experience and good judgment he was director in many of the most successful cotton manufacturing corporations in New England.

Mr. BURKE was twice married, first to CATHERINE FRENCH, by whom he had five children, of whom only two (1902) are now living, ANNIE ALVORD and EDWARD NEVINS, now with the Lowell Machine Shop. His second wife was ELIZABETH MARY DERBY, who survived him, but died February, 1900. He was one of the charter members of the Association, April 20, 1865.

JOHN HILL.

JOHN HILL, civil and mechanical engineer, was born Sept. 6, 1839, at New Salem, Illinois, son of SAMUEL and PARTHENIA (NANCE) HILL; grandson of JONATHAN and MARTHA (CLARK) HILL of Flemington, N. J. He prepared for college at Jubilee, Illinois, completing his education at McKendree College, Lebanon, Illinois.

His father was a merchant and manufacturer, died in 1857, and on Mr. HILL'S return from college he assumed charge of his father's interests, erecting and operating for several years a large woolen mill which was later destroyed by fire. He was

actively engaged in the Lincoln-Douglass campaign, supporting Douglass vigorously. He was the editor of a local newspaper in Petersburg, Ill. and the author of several well known campaign documents. He was a delegate to the Charleston Convention in 1860 and at the age of 26 served as a member of the 24th General Assembly of Illinois. During the Civil War Mr. HILL served as a commissioner from the Illinois state government to the Illinois regiments.

After the destruction of his mill he became manager of the Home Mfg. Co., Jacksonville, Ill. In 1872 he moved to Columbus, Ga., becoming the superintendent of the woolen department of the Eagle and Phœnix Mills. Afterwards he was made engineer for these mills and remained in this capacity until 1892. He erected the principal buildings of this plant and was widely known throughout the South and East as a mill expert. Among the principal mills he engineered are the John P. King Mills, Augusta, Ga., Lane Cotton Mills, New Orleans, La., and the Alabama State Mills. Mr. Hill was a pioneer in the introduction of advanced cotton mill processes, designing many of the same that have exerted marked influence on the economical manufacture of cotton goods.

He was the inventor of the automatic sprinkler bearing his name, and several other devices pertaining to cotton machinery and fire protective devices. He was the pioneer agent of the Edison company in the South and his introduction of electric lighting in the Eagle and Phœnix Mills made these mills the first to use electricity for lighting purposes. Mr. HILL formed the Hill Automatic Sprinkler Co., the Neracher & Hill Sprinkler Co., Warren, Ohio, and later combined his interest with the General Fire Extinguisher Co., Providence, R. I. He was engineer of the extensive water power developments at Columbus, Ga., and elsewhere throughout the South. At the time of his death, Jan. 20, 1898, he was engaged in the development of the power at North Highlands on the Chattahoochee river. Mr. HILL was a well known writer on mechanical subjects and a contributor to many textile and mechanical publications.

He married LULA CLARA CRAWLEY of Jacksonville, Ill., and was the father of PERRY N. HILL, electrical engineer of the Columbus Power Co., Columbus, Ga., and JOHN HILL, Atlanta, Ga., southern representative of the Lowell Machine Shop, Lowell, Mass. He became a member of the Association Oct. 25, 1876.

PROCEEDINGS.

In accordance with the legal notice, the stated annual meeting of the Association was held in Chipman Hall, Boston, Mass., April 23rd and 24th, 1902. The following 239 members and 105 guests were present:

ACTIVE MEMBERS.

ALFRED E. ADAMS, Whitinsville, Mass.
JOSEPH D. AIKEN, Taftville, Conn.
THOMAS ARMSTRONG, No. Pownal, Vt.
EDWARD ATKINSON, Boston, Mass.
H. C. ATWOOD, Providence, R. I.
NATHANIEL F. AYER, Boston, Mass.
LEWIS E. BARNES, Methuen, Mass.
EDWIN N. BARTLETT, No. Oxford, Mass.
JOSEPH P. BATTLES, Worcester, Mass.
ROBERT BEATTY, Philadelphia, Pa.
RICHARD B. BORDEN, Fall River, Mass.
STEPHEN N. BOURNE, Manchester, N. H.
FRANK A. BOWEN, Lowell, Mass.
ARTHUR F. BRACKETT, Riverpoint, R. I.
A. W. BRAINERD, Millville, N. J.
CHRISTOPHER P. BROOKS, New Bedford, Mass.
O. S. BROWN, Salmon Falls, N. H.
ROBERT BURGESS, New Bedford, Mass.
EDWARD N. BURKE, Lowell, Mass.
WILLIAM D. CADWELL, Nashua, N. H.
JOHN F. CAMPBELL, New York Mills, N. Y.
CLARENCE N. CHILDS, Lowell, Mass.

JOHN H. C. CHURCH, Gt. Barrington, Mass.
W. H. CLOHER, Jr., Capron, N. Y.
CHARLES H. COLLINS, Ashton, R. I.
B. B. COMER, Birmingham, Ala.
FRANK B. COMINS, Boston, Mass.
JOHN J. CONNELL, Lowell, Mass.
RICHARD COWELL, Lowell, Mass.
WILLIAM J. CRAY, Moosup, Conn.
P. T. CREED, Taunton, Mass.
H. H. CULVER, Taunton, Mass.
WOODBURY K. DANA, Westbrook, Me.
AUGUSTUS DECORT, Boston, Mass.
CHARLES W. DENNETT, North Adams, Mass.
EDWARD P. DENNIS, Lowell, Mass.
CHARLES A. DENNY, Leicester, Mass.
P. Y. DENORMANDIE, Boston, Mass.
HENRY C. DEXTER, Pawtucket, R. I.
HARRY K. DREW, Woonsocket, R. I.
FRANK J. DUTCHER, Hopedale, Mass.
BENJAMIN M. EARLE, Walnut Hill, Mass.
RUSSELL W. EATON, Brunswick, Me.
JOHN ECCLES, Taftville, Conn.
FREDERICK W. ELY, Greenville, N. H.
WILLIAM EVANS, Fall River. Mass.
CHARLES H. FISH, Dover, N. H.
WILLIAM B. FITTZ, Easthampton, Mass.
F. C. FLETCHER, Providence, R. I.
M. F. FOSTER, Milford, N. H.
ARTHUR C. FREEMAN, New York, N. Y.
C. H. FRISBIE, Norwich, Conn.
JAMES GEE, Fiskville, R. I.
CHARLES E. GETCHELL, Waltham, Mass.
MARCELLUS GOULD, Penacook, N. H.
GEORGE P. GRANT, Jr., Fitchburg, Mass.
D. W. GRAY, Utica, N. Y.
R. A. GRAY, Allenton, R. I.
JOHN GREGSON, Fiskdale, Mass.
MAXWELL GRIERSON, Jersey City, N. J.
DAVID GROVE, Central Falls, R. I.

ARTHUR H. GULLIVER, Waltham, Mass.
FRANK J. HALE, Newton Upper Falls, Mass.
WALTER B. HALL, Pontiac, R. I.
WILLIAM E. HALL, Lowell, Mass.
Z. D. HALL, Adams, Mass.
WILLIAM HALLIWELL, Woonsocket, R. I.
JOHN F. HAMLET, Fall River, Mass.
WILLIAM D. HARTSHORNE, Lawrence, Mass.
ALFRED HAWKESWORTH, Montreal, P. Q.
FRED HAWKESWORTH, Montreal, P. Q.
WILLIAM HAYES, Auburn, Me.
W. G. HENDERSON, Norwich, Conn.
CHARLES H. HOBBS, Thorndike, Mass.
FRANKLIN W. HOBBS, Boston, Mass.
WILLIAM HENRY HOBBS, New Brunswick, N. J.
WILLIAM P. HOLT, Fall River, Mass.
EDWARD W. HOUGHTON, Woonsocket, R. I.
HENRY S. HOUGHTON, Jr., Northbridge, Mass.
OTIS L. HUMPHREY, Lowell, Mass.
DAVID S. JOHNSTON, Cohoes, N. Y.
FRANK E. KALEY, Milford, N. H.
W. E. KEACH, Fitchburg, Mass.
NATHANIEL B. KERR, Lowell, Mass.
JOHN KILBURN, Belmont, Mass.
JESSE A. KNIGHT, Taunton, Mass.
STEPHEN A. KNIGHT, Providence, R. I.
JOHN EDWARD LAWTON, Matlock, Derbyshire, England.
C. H. LEE, Readville, Mass.
EVAN ARTHUR LEIGH, Boston, Mass.
CHARLES F. LIBBY, Lowell, Mass.
ARTHUR H. LOWE, Fitchburg, Mass.
WILLIAM L. LYALL, Passaic, N. J.
JAMES R. MACCOLL, Pawtucket, R. I.
FREDERICK B. MACY, New Bedford, Mass.
CHARLES R. MAKEPEACE, Providence, R. I.
JOHN R. MASON, Fall River, Mass.
THOMAS MAYOR, Providence, R. I.
ROBERT MCARTHUR, Biddeford, Me.
ROBERT G. MCMEEHAN, Woonsocket, R. I.

WILLIAM P. MCMULLAN, Salem, Mass.
JOHN TEMPEST MEATS, Taunton, Mass.
H. P. MEIKLEHAM, Lindale, Ga.
W. H. MILES, Lisbon, Me.
JAMES I. MILLIKEN, Lawrence, Mass.
EDWARD A. MONGEON, Lonsdale, R. I.
J. R. MONTGOMERY, Windsor Locks, Conn.
GEORGE B. MORISON, Boston, Mass.
ALBERT H. MORTON, Lowell, Mass.
E. P. MORTON, Webster, Mass.
OLIVER H. MOULTON, Lowell, Mass.
ALBERT W. NOONE, Peterboro, N. H.
HENRY OSGOOD, Salem, Mass.
ELMER E. PAGE, Saco, Me.
WALTER E. PARKER, Lawrence, Mass.
WILLIAM C. PEIRCE, Providence, R. I.
HAVEN C. PERHAM, Lowell, Mass.
R. PILLING, Providence, R. I.
CHARLES T. PLUNKETT, Adams, Mass.
CHARLES H. POTTER, Valleyfield, P. Q.
HERBERT L. PRATT, Lewiston, Me.
JOHN E. PREST, Cohoes, N. Y.
M. W. QUINN, Amesbury, Mass.
JOHN F. REARDON, Norwich, Conn.
ROBERT REDFORD, Lawrence, Mass.
BENJAMIN H. ROBERTS, Fall River, Mass.
ALFRED SAGAR, Methuen, Mass.
RICHARD W. B. SANDERSON, Providence, R. I.
J. HERBERT SAWYER, Boston, Mass.
THOMAS C. SHELDON, Fitchburg, Mass.
HERBERT H. SHUMWAY, Taunton, Mass.
J. C. SMITH, Fall River, Mass.
JAMES HERBERT SMITH, Danielson, Conn.
THOMAS HENRY SMITH, Jamestown, N. Y.
WILTON H. SPENCER, Providence, R. I.
GEORGE E. SPOFFORD, Blackstone, Mass.
T. B. STEVENSON, Hyde Park, Mass.
ROBERT STEWART, Ashton, R. I.
WALTER F. STILES, Fitchburg, Mass.

WALTER H. SUMMERSBY, Lawrence, Mass.
D. G. SUNDERLAND, Pelham, S. C.
JAMES O. SWEET, Jewett City, Conn.
JAMES W. TAYLOR, Taunton, Mass.
W. MARSHALL TAYLOR, Holyoke, Mass.
RICHARD THACKERAY, Fall River, Mass.
EARL A. THISSELL, Woonsocket, R. I.
EDWARD W. THOMAS, West Durham, N. C.
D. M. THOMPSON, Providence, R. I.
JAMES P. TOLMAN, Boston, Mass.
D. A. TOMPKINS, Charlotte, N. C.
GEORGE W. TOWNE, Columbus, Ga.
C. H. TRUESDELL, Killingly, Conn.
OSCAR B. TRUESDELL, Newtonville, Mass.
ROBINSON WALMSLEY, Fall River, Mass.
W. B. SMITH WHALEY, Columbia, S. C.
ALFRED N. WHITING, Worcester, Mass.
GEORGE F. WHITTEN, Manchester, N. H.
JOHN H. WHITTEN, Manchester, N. H.
HENRY M. WILCOX, Millbury, Mass.
JOHN B. WILD, Utica, N. Y.
WILLIAM D. WINCHESTER, Philadelphia, Pa.
C. J. H. WOODBURY, Lynn, Mass.
ADELBERT R. YOUNG, Jewett City, Conn.

ASSOCIATE MEMBERS.

HENRY B. ASHTON, Medford, Mass.
HENRY ASHWORTH, Fall River, Mass.
WILLIAM H. BENT, Taunton, Mass.
F. H. BISHOP, Boston, Mass.
ARTHUR T. BRADLEE, Boston, Mass.
J. FRANK BRAIDS, Providence, R. I.
HENRY G. BRINCKERHOFF, Boston, Mass.
H. MARTIN BROWN, Providence, R. I.
JOHN H. BURGHARDT, Boston, Mass.
EUGENE E. BURNHAM, Lawrence, Mass.
JAMES BUTTERWORTH, Philadelphia, Pa.
MALCOLM CAMPBELL, Woonsocket, R. I.

W. W. CAREY, Lowell, Mass.
CHARLES H. CHILD, Providence, R. I.
C. F. CURWEN, Salem, Mass.
JOSEPH L. CUSHING, Lowell, Mass.
E. W. DAVENPORT, Providence, R. I.
JOHN O. DEWOLF, Boston, Mass.
C. E. W. DOW, Atlanta, Ga.
G. B. EMMONS, Lawrence, Mass.
T. C. ENTWISTLE, Lowell, Mass.
JOHN T. FYANS, Fall River, Mass.
H. P. GARLAND, Biddeford, Me.
ROYAL W. GATES, Lowell, Mass.
RUFUS B. GOFF, Providence, R. I.
SUMNER S. GOULD, Lowell, Mass.
WILLIAM S. GRANGER, Providence, R. I.
ARTHUR F. GRAY, Boston, Mass.
EDWIN FARNHAM GREENE, Boston, Mass.
ALFRED H. HARTLEY, Fall River, Mass.
HENRY A. HOLCOMB, New Bedford, Mass.
HENRY S. HOUGHTON, Sr., Woonsocket, R. I.
LEWIS T. HOUGHTON, Worcester, Mass.
A. H. HOWARD, Worcester, Mass.
FREDERIC W. HOWE, Providence, R. I.
C. H. HUTCHINS, Worcester, Mass.
DAVID JACKSON, Pawtucket, R. I.
LAWRENCE M. KEELER, Whitinsville, Mass.
FRANK B. KENNEY, Lowell, Mass.
W. C. LANGFORD, Providence, R. I.
SANFORD E. LORING, Syracuse, N. Y.
STEPHEN C. LOWE, New Bedford, Mass.
FAY H. MARTIN, Boston, Mass.
JOHN MCCULLOUGH, New Bedford, Mass.
H. G. MCKERROW, Boston, Mass.
CHARLES B. MOORE, Boston, Mass.
ROBERT W. NEFF, Boston, Mass.
JOHN H. NELSON, Boston, Mass.
WILLIAM R. NOONE, Boston, Mass.
SIDNEY B. PAINE, Boston, Mass.

ARTHUR PARKINSON, New York, N. Y.
STEPHEN MINOT PITMAN, Providence, R. I.
CHARLES A. M. PRARAY, Providence, R. I.
PELEG A. RHODES, Providence, R. I.
E. R. RICHARDSON, Pawtucket, R. I.
JOHN M. RUSSELL, Worcester, Mass.
DWIGHT SEABURY, Pawtucket, R. I.
WILLIAM N. SHAW, Readville, Mass.
HARRY M. SMITH, Providence, R. I.
HENRY C. SPENCE, Indian Orchard, Mass.
H. E. SLAFFORD, Readville, Mass.
JAMES STRANG, Indian Orchard, Mass.
CHARLES F. TAYLOR, Providence, R. I.
GEORGE C. TEWKSBURY, Boston, Mass.
WILLIAM V. THRELFALL, Biddeford, Me.
JAMES T. THORNTON, Providence, R. I.
RIENZI W. THURSTON, Fall River, Mass.
A. CURTIS TINGLEY, Providence, R. I.
ALLISON W. TRAFFORD, Fall River, Mass.
CLEMENT A. WAKEFIELD, Biddeford, Me.
LETTICE R. WASHBURN, New Bedford, Mass.
ROBERT C. WEBSTER, Boston, Mass.
W. W. WHITE, Worcester, Mass.
G. MARSTON WHITIN, Whitinsville, Mass.
FRED A. WILDE, Pawtucket, R. I.
ERVING YALE WOOLLEY, Boston, Mass.

GUESTS.

A. A. ASPINWALL, Pawtucket, R. I.
W. W. BALLAGH, New York, N. Y.
HOWARD W. BEALE, New York, N. Y.
MURRAY C. BEEBE, Pittsburg, Pa.
HOWARD W. BIBLE, New York, N. Y.
L. M. BINGHAMPTON, New Bedford, Mass.
A. H. BIXBY, Providence, R. I.
E. E. BLAKE, Newton Upper Falls, Mass.
L. M. BUGHUNTER, New Bedford, Mass.
FRANK H. BURT, Boston, Mass.

ARCH. B. CALVERT, Spartansburg, S. C.
W. W. CHRISTIE, Paterson, N. J.
CHARLES M. CLARRY, Boston, Mass.
M. H. COFFIN, Whitinsville, Mass.
J. A. COOPER, Whitinsville, Mass.
W. P. COTHARIN, Boston, Mass.
WILLIAM W. CROSBY, Lowell, Mass.
H. C. DAGGETT, Worcester, Mass.
SAMUEL S. DALE, Boston, Mass.
CYRUS E. DALLIN, Boston, Mass.
WALTER J. DENNY, Lowell, Mass.
HARRY I. DODGE, Providence, R. I.
Rev. Mr. DUMBELL, Great Barrington, Mass.
HENRY WEBB EDWARDS.
D. D. ELDER, Jr., New York, N. Y.
GEORGE P. ERHARD, Readville, Mass.
W. A. ERWIN, West Durham, N. C.
L. C. FARNSWORTH, Providence, R. I.
EUGENE FINOCCHIARO, Boston, Mass.
C. P. GAITHER, Boston, Mass.
W. E. GLEAM, Providence, R. I.
M. E. GLEASON, Providence, R. I.
W. B. GRABHARD, Savannah, Ga.
MITCHELL GRAY, Burnley, Lancashire, England.
E. L. GREEN, Boston, Mass.
RICHARD A. HALE, Lawrence, Mass.
J. F. HANEY, Boston, Mass.
J. T. HANSEN, Macon, Ga.
GEORGE S. HARRIS, Cedartown, Ga.
W. C. HARRISON, Boston, Mass.
WILKINSON HARTLEY, Nelson, Lancashire, England.
M. A. HAYS, Boston, Mass.
H. L. HERLEY, Utica, N. Y.
HENRY HIGSON, Blackburn, Lancashire, England.
GEORGE PICKUP HOLDEN, Darwin, Lancashire, England.
J. F. HOVEY, Boston, Mass.
ARTHUR E. HOWES, Boston, Mass.
SAMUEL T. HUBBARD, New York, N. Y.

WILLIAM HUSTACE HUBBARD, Yonkers, N. Y.
JAMES B. JONES, Philadelphia, Pa.
A. H. KELLOGG, Waltham, Mass.
HERBERT A. KENNY, Boston, Mass.
JOSEPH C. KING, Boston, Mass.
WALTER L. LANE, Boston, Mass.
Mr. LIVESY, Bolton, England.
HENRY G. LORD, Boston, Mass.
ALEXANDER MACNABB, Glasgow, Scotland.
ALEXANDER MAKEPEACE, Fall River, Mass.
JOHN W. MAYOR, Providence, R. I.
AUSTIN A. MCAULIFF, Fall River, Mass.
J. H. MCCORMACK, Boston, Mass.
CHARLES H. MEADER, Boston, Mass.
FREDERICK MEBANE, Queensboro, N. C.
E. L. MERROW, Providence, R. I.
J. R. MONTGOMERY, Jonesville, Ga.
JOHN H. MONTGOMERY, Spartansburg, S. C.
FRANK H. MORRISON, Pittsburg, Penn.
E. H. MULLEN, New York, N. Y.
CHARLES M. MUMFORD, Providence, R. I.
G. H. MUSGRAVE, Boston, Mass.
FRANK L. NAGLE, Boston, Mass.
W. C. NAIRN, Lawrence, Mass.
T. E. NICHOLSON, Boston, Mass.
C. H. NOONE, Boston, Mass.
F. G. PAGE, Boston, Mass.
MOSES G. PARKER, Lowell, Mass.
GEO. G. PARLOW, Fall River, Mass.
DARIUS PHILLIPS, Trainer, Pa.
A. F. RAY, Boston, Mass.
JAMES RANDOLF, Boston, Mass.
M. J. REAGAN, New York, N. Y.
R. L. REYLOLDS, Fall River, Mass.
Dr. C. A. SEILZ, New York, N. Y.
D. T. SHACKLETON, Darwin, Lancashire, England.
GEO. H. SHERMAN, Providence, R. I.
GEO. F. SHILE, Boston, Mass.

CHARLES T. SLACK, Fall River, Mass.
H. P. SMITH, New Bedford, Mass.
J. R. SMITH, Preston, Lancashire, England.
H. C. SPAULDING, Boston, Mass.
GEO. F. STEELE, Boston, Mass.
J. STEPHENS, Pawtucket, R. I.
H. STEPHENSON, Boston, Mass.
WILLIAM J. STEWART, Webster, Mass.
W. G. STROBHAR, Savannah, Ga.
W. A. TATTERSALL, Checkheaton, England.
JOHN TAYLOR, Blackburn, Lancashire, England.
HENRY P. THOMPSON, Pawtucket, R. I.
C. M. THORN, Utica, N. Y.
GEO. E. TROWBRIDGE, Whitinsville, Mass.
E. H. WALKER, Lowell, Mass.
M. M. WARWICK, Chicopee, Mass.
WILLIAM O. WEBBER, Boston, Mass.
W. H. WILLS, Waltham, Mass.
T. M. YOUNG, Manchester, England.

FIRST SESSION.

CHIPMAN HALL, BOSTON, MASS.,
WEDNESDAY, April 23, 1902.

The meeting was called to order at 11 A. M., President CHARLES H. FISH in the chair.

The PRESIDENT. You will please come to order, gentlemen. We will open this convention by the reading of the call by the Secretary.

The Secretary read the following call for the meeting:

BOSTON, MASS., April 1, 1902.

To the Members:

Notice is hereby given that the stated Annual Meeting of this Association will be held at Boston, Mass., Wednesday and Thursday, April 23 and 24, 1902.

The sessions will be held in Chipman Hall, in the Tremont Temple, No. 88 Tremont Street, a short distance south of School Street, and opposite the Tremont Building. The entrance is at No. 88 Tremont Street, and Chipman Hall is on the sixth floor, reached by elevators.

The sessions will be called to order on Wednesday at 11 A, M., and 2 P. M., and on Thursday at 10 A. M., and 2 P. M.

By order of the Board of Government,

C. J. H. WOODBURY,

Secretary.

The call was accompanied by the following notice:

It is expected that His Honor P. A. COLLINS, Mayor of Boston, will greet the members with a welcome at the opening session.

The Board of Government especially hope that at this meeting the various papers will receive a full discussion and that inability to attend the meeting may not be considered by any one an impediment, as discussions may be written and sent to the Secretary to be read. For the purpose of furnishing better facilities for a discussion, the papers are to be printed in advance, if the manuscripts are received in time by the Secretary, and copies of such papers will be sent on request to any members five days before the meeting.

The full programme will not be issued until the meeting, but papers are expected on the following subjects:

Use of Business Organizations.
Brick Factory Chimneys: Some Features of their Construction.
Methods of Cotton Textile Instruction.
Thread Boards and Guides for Wet Twisting.
Japanese Cotton Mills.
Flyers.
A New Combing Machine.
Viscose, as Applied to Textiles.
Hydraulic Compression of Air.
Knots and Knot Tying.
An Electric Driven Cotton Mill.
The Electric Drive for Cotton Mills.
The Nernst Lamp in Industrial Establishments.
The Whittam Metallic Thread Board.

The New England Telephone and Telegraph Co. will place two telephone booths in the corridor outside of the hall for the free use of the members for Boston and vicinity during the day, and before 10.00 A. M. and after 4.00 P. M. free telephone service over the states of Maine, New Hampshire, Vermont and Massachusetts. The American Telephone and Telegraph Co. will give free long distance service to members beyond this territory before 10.00 A. M. and after 6.00 P. M.. In this, as in all the other privileges of the Association, candidates for membership will receive the same privileges as the members.

The souvenir badges will be given to those members who are in attendance, and the Board of Government has given instructions that

duplicates shall not be given until after the adjournment, but other souvenir badges will be given to the guests of members.

It is desired that applications for membership shall be received as far as possible in advance of the meeting. Blank propositions are enclosed herewith or may be found on the inside front cover of the Transactions or will be sent on application.

Members who have overlooked their postal card receipts for Transactions are requested to give the matter attention, as it is only through this means that the headquarters of the Association are able to know that members receive the volumes and notices to which they are entitled, and to keep an accurate record for sending Transactions and notices to members.

The office is endeavoring to obtain a complete necrology of the past members of the Association, and it would be an esteemed favor if members will look over the proof sheet which will be sent in the middle of April and supply any omission or correction of date of death of those of the past members who are not now living.

The donation of WILLIAM FIRTH, Esq., has established a scholarship at the New Bedford Textile School primarily for the benefit of the son of a member or of a deceased member of the New England Cotton Manufacturers' Association, furnishing to the recipient of such scholarship, tuition, books and supplies for the course. Candidates for that scholarship will apply by letter only, addressed to the New England Cotton Manufacturers' Association, P. O. Box 3672, Boston, Mass. The candidates must be at least fourteen years of age and furnish certificates of good moral character, and those who have been students of other technical institutions, colleges or universities, will be required to furnish certificates of honorable dismissal from such institutions. Those applicants conforming to the above conditions will be nominated by the Board of Government to the New Bedford Textile School, and the selection of the candidate for the scholarship will be made as the result of an examination to be held in the lecture hall of the School at New Bedford Mass., on Friday, September 12, 1902, at 10 00 A. M., or such other date as the Managing Director of the School may notify the candidates. Every candidate, previous to the entrance examination, must file an application at the School for admission, agreeing to observe the rules and regulations of the School. The courses of instruction for which candidates will be eligible are as follows: No. 1, the General Cotton Manufacturing Course, which is a three years' course; No. 2,

the Yarn Mill Superintendents' Course, which is a one year's course; No. 3, the Weaving Mill Superintendents' Course, which is a one year's course; No. 4, the Designers' Course, which is a two years' course.

Candidates applying for the General Cotton Manufacturing Course, No. 1, will have preference over other candidates, as this is the most comprehensive of any of the courses in the School and is intended to give the student a general knowledge of all the cotton manufacturing processes, and sufficiently specific and complete information to qualify him to hold a position as superintendent of a cotton spinning and weaving mill, or other responsible post.

Any information not provided for in this circular, or conditions of enrollment not previously referred to, will follow the conditions as specified in the official catalogue of the New Bedford Textile School, which may be obtained on application to the Managing Director, New Bedford Textile School, New Bedford, Mass.

The sculptor's plaster cast for the bronze memorial tablet to be erected to Eli Whitney at Rocky Creek, Georgia, will be on exhibition at Chipman Hall during the meeting.

The SECRETARY. Mr. President, I certify that in accordance with article 14 of the by-laws, a copy of this notice was mailed to each member at least ten days in advance of this meeting, and that a quorum is now present.

The records of the last meeting were read by the Secretary and accepted.

PROGRAMME.

First Session, Wednesday, April 23, 1902, at 11 A. M.

Call to Order.

Election of Officers.

Welcome to the Association.

HIS HONOR, P. A. COLLINS, Mayor of the City of Boston.

President's Address.

CHARLES H. FISH, Dover, N. H.

Use of Business Organizations.
SAMUEL T. HUBBARD, President New York Cotton Exchange, New York.

Report of the Secretary and Treasurer.

Award of the Association Medal.
A. E. ADAMS, Chairman of Committee.

Methods of Cotton Textile Instruction.
W. W. CROSBY, Lowell, Mass.

Brick Factory Chimneys: Some Features of their Construction.
WILLIAM WALLACE CHRISTIE, C. E., Paterson, N. J.

Second Session, Wednesday, April 23, 1902, at 2 P. M.

Hydraulic Compression of Air.
(Illustrated by the Stereopticon).
W. O. WEBBER, C. E., Boston, Mass.

Flyers.
FAY H. MARTIN, Boston, Mass.

Knots and Knot Tying.
ROBERT C. WEBSTER, Boston, Mass.

Thread Boards and Guides for Wet Twisting.
LEWIS T. HOUGHTON, Worcester, Mass.

The Whittam Metallic Thread Board.
RICHARD THACKERAY, Fall River, Mass.

Third Session, Thursday, April 24, 1902, at 10 A. M.

A New Combing Machine.
JOSEPH NASMITH, Manchester, England.

An Electric Driven Cotton Mill.
JOHN O. DEWOLF, Boston, Mass.

The Electric Drive for Cotton Mills.
W. B. SMITH WHALEY, Columbia, S. C.

Fourth Session, Thursday, April 24, 1902, at 2 P. M.

Election of Members.

The Nernst Lamp in Industrial Establishments.
(Illustrated by the Stereopticon).
MURRAY C. BEEBE, Pittsburg, Pa.

Viscose, as Applied to Textiles.
CHARLES N. WAITE, 35th St. and Gray's Ferry Road, Philadelphia, Pa.

Japanese Cotton Mills.
TETSUTARO INUMARU, Tokio, Japan.

The telephone booths in the corridor are placed by the New England Telephone and Telegraph Company for the free use of the members for Boston and vicinity during the day, and before 10.00 A. M. and after 4.00 P. M. free telephone service over the states of Maine, New Hampshire, Vermont and Massachusetts.

At these booths the American Telephone and Telegraph Company give free long distance service to members beyond this territory before 10.00 A. M. and after 6.00 P. M.

In this, as in all the other privileges of the Association, candidates for membership will receive the same privileges as the members.

The souvenir badges will be given to those members who are in attendance, and the Board of Government has given instructions that duplicates shall not be given until after the adjournment, but other souvenir badges will be given to the guests of members.

A limited number of tickets, each admitting the bearer with friends, including ladies, to the Sixty-sixth Exhibition of Paintings at the Boston Art Club, Corner of Dartmouth and Newbury streets, open from 9.00 A. M. to 10 P. M., may be obtained from the Secretary.

ELECTION OF OFFICERS.

The PRESIDENT. The next business in order is the election of officers for the ensuing year. By the expiration of terms and by retirement the positions of president, of two vice-presidents, two directors for three years and one director for two years are vacant.

Mr. WALTER E. PARKER. I move that a committee of five be appointed to bring in a list of nominations for officers for the ensuing year.

The motion was seconded and carried, and the president appointed as such committee Messrs. WALTER E. PARKER, STEPHEN A. KNIGHT, HERBERT L. PRATT, M. F. FOSTER and EDWARD N. BURKE.

The PRESIDENT. This committee can retire at their leisure and will report at one of the sessions tomorrow.

WELCOME TO THE CITY OF BOSTON.

The PRESIDENT. Gentlemen, we are honored by the presence of one whom every mill man, every manufacturer, must admire and appreciate. We have all had our experiences in new positions, and we all remember well the difficulties that we have had in reorganization, and especially with the great bugbear of costs. This gentlemen with us has attacked this question of costs like a veteran manufacturer, and he has obtained the veteran's results. I have the very great honor of presenting to you His Honor, P. A. COLLINS, Mayor of the city of Boston. [Applause.]

Hon. PATRICK A. COLLINS. Mr. President and gentlemen, I have snatched a few minutes from one of the busiest days of my life to come and unite with the Sun in giving you a Boston welcome. When I woke up this morning and saw the frown of the gray skies I had an apprehension that perhaps your organization would not receive from nature the welcome that it since has been accorded. It is a very great pleasure to say a Boston word to an organization like yours, which has done, during the period of its existence, so much for the interests of Boston, the center of New England industries. Up in this corner of the world we have little natural wealth, and it might be said with frankness and truth that we live by our wits and on the rest of the country and on the rest of the world. I notice by your programme that your objects are rather more scientific than commercial. The future of New England lies in the excellence of its work, the finer touch, the higher development of

its industries. The city for which I have the honor to speak to you today in giving you a few words of welcome, would not exist were it not for the skill and the enterprise of our people, and the industries themselves would not exist so far from the field of natural production were it not for the superiority of our industrial classes. I do not know that there is anything more to say, except to congratulate you upon the felicity of your choice of convention place. We claim that Boston is preëminently the convention city for all industrial organizations Geographically, it is up here in this corner of the land; politically, it does not cut any very great figure — perhaps it does not count; but industrially, it is the advance point of American activity.

I understand also that yours is not a wholly New England organization; it is an organization representing all the textile industries in the cotton line throughout the country. I hope that your visit to Boston will be a pleasant one. I do not suppose there is a man present from a distance who has not been in Boston before. If there be one I congratulate him on having a new impression, because we are very proud of our city and we hope to be still more proud of it when it receives the approbation of so many great organizations, expressed by their making it their meeting point. I thank you for your attention and regret that I cannot say anything interesting here, but if I were to speak about your trade, if I were to say anything about your industry, it would be speaking to a body of experts, and I am too modest to do that. [Applause.]

PRESIDENT'S ADDRESS.

CHARLES H. FISH, Dover, N. H.

Gentlemen of the New England Cotton Manufacturers' Association.

That mighty personification of perpetual motion, the Wheel of Time, has completed another revolution and we meet again here at our own Home.

It is with great pleasure that I, as your President, greet you and welcome you all to this the Seventy-second Convention of this Association, and I do congratulate you, gentlemen, upon the fact that no matter how fast this Wheel revolves (and you know it moves faster and faster each year) or no matter how many of us finish our life's work and fall from the line, we, as an Association, the New England Cotton Manufacturers' Association, with the impetus already obtained, will continue moving steadily forward, growing stronger year by year, an ever increasing factor in the cotton industry of our Country.

Today we find ourselves in a most satisfactory condition with brilliant prospects for the future. Our standing among the technical associations of the world is such that to be a member of this Association is an honor, which you must not under-estimate. Our time is not yet come, however, and in fact it never will come, when we, or our successors, can afford to rest on the oars or allow our interests to flag in the slightest degree.

The progress of the world compels concerted, as well as intelligent and energetic action.

It should be your pleasant duty to keep constantly in touch with your Association, which must some day be the one great

representative body of cotton manufacturers of North America, in all that pertains to the rapidly advancing forefront of the progress of every thing that is tributary to fabrication of cotton into cloth.

This is no slight generalization, as the work of the members of this Association represents the culmination at the present day of the prehistoric process of clothing humanity, amplifying in the amount of material and artistic taste with every step in the development of mankind, from the savage to the enlightened people of today.

This textile art embraces the highest applications of the various branches of engineering, the wonderful creations of invention, the discoveries of chemistry, the gathering of the beauties of Nature into the conventionalized artistic designs of modern fabrics, but above all, it represents the concentration of skill, industry and intelligence in the organization of the modern mill by which the coöperation of all measures of intelligence and all measures of skill may become tributary to the final results.

That we enlarge our active membership is most important. I trust that the time is not far distant when we shall have among our members representatives from every cotton mill in this great northern hemisphere.

The past year has been, perhaps, of unusual interest. Our fall meeting at Buffalo was one of great pleasure and benefit. The distinguished consideration shown the Association by the officials of the Pan-American Exhibition and the Buffalo Board of Trade was not without its effect.

Among matters of special interest, however, I would mention the establishing at the New Bedford Textile School, the William Firth Scholarship, made possible by the public spirited generosity of Mr. WILLIAM FIRTH, a member of this Association.

In the same connection, I am pleased also to call to your notice the awarding during the year of five scholarship medals, to pupils in the textile schools.

The importance of the technical education becomes more ap-

parent each day and it is our special duty to encourage and to assist this branch of education in every way possible.

I would also briefly allude to the beautiful bronze tablet (a model of which you see before you) which is to be erected by the Association from funds collected by subscriptions from members and friends, a fitting testimonial to the inventor of the cotton gin, ELI WHITNEY.

Important changes and improvements have been made during the year, the details of which are presented in the Secretary's report. The old methods long since outgrown have been superceded by a complete and modern system, by which it is now possible to conduct affairs of the Association on business principles, largely to the benefit of the Association and its members.

All these matters are of direct interest to each of you and I trust that all alike will manifest your approval by coöperating with your officers in the discharge of their duties. Without this coöperation, gentlemen, the task assigned to them is almost a thankless one, but with your coöperation and your sympathy, the task is one of pleasure and heightens the appreciation of the honor bestowed.

Touching briefly upon a subject of immediate interest and of utmost importance to us all, I regret to note the condition of unrest, growing more and more apparent among the operatives of the factories, in nearly every manufacturing district of the country. Some relief must be found, or some means provided whereby the conflicts which are becoming of almost daily occurrence, I will not say between capital and labor necessarily, but between employer and employee, can be avoided, for they must in time work results fatal, perhaps to both. In the consideration of this question, it is impossible to separate the interests of the two. You cannot to any extent injure the one without detriment to the other. The operative cannot be prosperous and happy unless the factory where he is employed is at least to some extent prospering, neither can you expect the factory to prosper in the long run, unless its operatives are

prosperous and contented. You will agree with me that it is the duty of employers to be fair and just at all times to those in their employ, allowing to them the maximum wages that circumstances or conditions will allow, and when they have honestly done this, the fairness of their position should be recognized and they should be free from damaging or annoying interference.

It is the uncertainty of the situation perhaps as much as the actual conditions, which interferes so seriously with the prosperity of all.

A prominent member of this Association once said that as long as a single bale of American cotton crossed the Atlantic, so long would there be room for more spindles in America.

Gentlemen, America has the ambition and energy, and she has the means; settle satisfactorily this great problem of capital, and labor, and remove this cloud of uncertainty which now hangs over us, and the time is not far distant when the only bales of cotton that cross the Atlantic will be on West bound steamers. The East bound to be sure will be loaded with cotton as now, but instead of its being raw cotton in bales, it will be the finished product, bearing the trade marks of America, a guaranty of superiority.

I wish for you all a most instructive and enjoyable convention.

The PRESIDENT. Gentlemen, we are particularly favored this morning by the presence, as our guest, of one who is the leader of an organization, the doings or undoings of which claim the attention at all times of the entire business world, and especially of cotton manufacturers. Their actions bring shouts of approval or cries of regret, depending not so much upon what they do as upon what we have done or what we have not done. I am much pleased to be able to present to you Mr. SAMUEL T. HUBBARD, president of the New York Cotton Exchange. [Applause.]

USE OF BUSINESS ORGANIZATIONS.

SAMUEL T. HUBBARD, President New York Cotton Exchange,
New York City.

It is a great pleasure for me, in my official capacity as a representative of the cotton trade of New York, to have the honor of appearing before the Cotton Manufacturer's Association of New England. The invitation was deeply appreciated by the Cotton Exchange, as we believe it to be the first time since the organization of our Exchange in 1870–71, that we have been brought into close relation with your Association, and we trust that it will mark the beginning of an era when the cotton merchant and the spinner may frequently meet to discuss questions of mutual interest for their mutual material improvement and to adopt measures to bring about such results. For their interests are not antagonistic but the welfare of one is wrapped up in the success of the other. To my mind the drifting apart of the two interests in the past has been entirely due to the lack of personal intercourse. We meet daily merchants and spinners from the South, Great Britain, Germany, Russia, Japan and India, but the New England spinner is seldom seen on the floor of our Exchange. Yet in other countries the spinner is not only to be seen at the cotton exchange but he uses its modern methods of transacting business to further his own material interests. He comes into direct personal contact with the forces which are operating upon the value of his raw material, receiving impressions which cannot be conveyed by the cold, didactic letter or telegram and above all becomes accustomed to *use* implements which are offered to him by these organizations.

Now it is my thought that a business organization furnishes the modern implements for the success of its members and they should be used with the same purpose that one would use a wrench, or a loom, to accomplish a desired result. Thus the German spinners have joined the cotton exchange in Bremen in large numbers and nearly every bale of cotton used in Germany passes through the hands of the paid classification committee of that institution. How many spinners in New England think of employing the paid experts of our Exchange to determine the questions of grade which constantly arise? The spinner of the South uses our market, both to protect his forward sales of yarns and frequently sells cotton in advance as a hedge against the stock on hand at his mill, either of raw material or of yarns. Last season was an illustration of the possibility of avoiding loss on a falling market for yarns and cottons by protection, which the balance sheets of the New England mills show was not attempted. Manchester uses Liverpool daily in seeking protection from possible fluctuations in values to the great benefit of all. In fact, after the break down in the spinning districts of Oldham in 1890, arising from holding large reserve supplies of cotton, the bankers abroad forced spinners to keep themselves hedged or protected in Liverpool and the recovery in that large spinning district of Lancashire is attributed to their adoption of this policy.

Let us now look at the use which can be made of a business organization to bring a positive force to bear to remedy the discriminations, either public or private which work against the interests of the trade they represent.

The Department of Agriculture at Washington issues each year about the 10th of December an estimate of the cotton crop of the United States. I have never known that estimate to be equal to the ultimate yield of the crop. It is always an under estimate. This season the estimate was that the average net weight for the entire cotton belt was 468 pounds per bale, which they stated was believed to be the lowest average in at least 10 years. On this basis they estimated the crop at 9,674,000 bales. On

the average weight of the cotton which had appeared before December first their estimate should have been 9,282,700 bales. Now in April the Census Bureau issued a statement that the crop ginned according to their returns was 9,952,000 bales of 483 net weight.

Here is a small discrepancy between two departments of the government of vital interest to the spinner as to the farmer, and I make the point that one is just as much entitled to the care of the government as the other. As a matter of fact the statistician of the Agricultural Department cannot tell just how it arrived at 9,674,000 as an estimate of this season's crop. What the crop will eventually turn out, no one knows but I believe it lies within the province of this Association to ascertain why crop estimates are always smaller than the actual yield.

Last week I appeared before the Commerce Committees of Congress in Washington on behalf of our Exchange to urge the passage of an amendment to the inter state commerce act which would make the recommendations of the Inter State Commerce Commission mandatory instead of advisory, as they have become by the decisions of the Supreme Court.

Cotton is now being carried to Europe for less money than to New England. The rate from New Orleans to Manchester, England, on the 8th of last March was 32 cents, while the rate to Fall River was 38 cents a hundred. Cotton bound to New York and consigned to New England points paid a higher freight rate than cotton in the same steamer bound for Liverpool or Bremen. Cotton shipped to Liverpool from Newport, Arkansas, pays a freight rate of 62 cents a hundred, while the rate to Lowell, Mass., was 75 cents. There are many other similiar discriminations which I will not take time to repeat. The railroads also exercise the right of routing your purchases of cotton by such roads as they, not *you*, select. In short, the cotton which has gone to Europe this season has been handed to spinners abroad at a lower rate of freight than it has been handed to you. It is admitted that ocean transportation rates have been lower than for many years, but it is not right that

cotton for export should be carried past your doors by transportation companies, incorporated under the American laws, at a lower rate than to you. In England a recent act of Parliament forbids such discrimination.

The future of the New England spinner is in the export trade where he must compete with the cotton spun in Europe and surely the best use which can be made of this influential body is to remedy these discriminations against the welfare of the members, either by the government or the railroads.

Therefore we see that business organizations have two distinct uses, one the individual one and the other the public duty of asserting the influence of the trade as a whole upon the government to secure equal privileges to all.

The PRESIDENT. Mr. HUBBARD, allow me to thank you on behalf of the Association for your very pleasant and instructive address. It has certainly given us much food for reflection.

The next in order is the report of the Secretary and Treasurer.

THE SECRETARY'S REPORT.

During the past year the general position of the Association has continued to broaden its scope beyond the limits of its membership, and such beneficient affairs must surely revert to the good of the organization and its purposes.

THE ASSOCIATION MEDAL.

The Board of Government have made an award of the Association medal which was established during the year 1899 and a fund set apart for its maintenance for the recognition of papers read before the Association and the acknowledgment of the worth of inventions and methods contributing to the advancement of the cotton textile art, the purpose being that it may give to any person whose work has been in their opinion an advantage of sufficient importance to the purposes to which this organization is devoted in its broadest sense, including any papers read before the Association, the production of any mechanism or processes in the fabrication, design or finishing of cotton goods, comprising mill construction, the generation of power and its distribution, or any of the works tributary to the cotton manufacture.

The preceding Board of Government, by the failure to hold an expected meeting, was unable to carry out its intention of making the award last year, and the present Board of Government have adopted what is believed to have been the preferences of individual members of the Board last year and have also awarded a second medal for the year just ended. The details will be included in the report of the special committee of the Board of Government having the matter in charge.

THE STUDENT'S MEDAL.

The Students' Medal established by the fund of MOSES PIERCE has been awarded through the recommendations of committees of members of the Association appointed for the purpose, to these students of the graduating classes who showed the highest general excellence at the following textile schools selected by the Board of Government as the beneficiaries of these medals:

Lowell School of Design, Mass. Institute of Technology, Boston.
To ARTHUR EUGENE SANFORD, 41 Corbet St., Dorchester, Mass.
Lowell Textile School, Lowell, Mass.,
To BARTHOLOMEW MOORE PARKER, Raleigh, N. C.
Philadelphia Textile School, Philadelphia, Pa.
To JAMES VOORHEES POMEROY, Graham, N. C.
New Bedford Textile School, New Bedford, Mass.
To NELSON ALLEN WOOD, New Bedford, Mass.
Georgia School of Technology, Atlanta, Ga.
To ALBERT SPAULDING MEAD, Decatur, Ga.

STANDARD YARN NUMBERING.

In January the Association was communicated with on behalf of the Congressional Committee on Coinage, Weights and Measures, who are considering the metric system in connection with R. H. Bill 2054, the object of the inquiry being to learn in what connection the metric system might be feasibly adopted for the standards of fabrics. The President appointed Mr. WILLIAM WHITMAN to represent the Association at the hearing held at Washington February 6, 1902, on which occasion he presented in connection with his testimony the Report of the International Congress for the Unification of the Numbering of Yarns which was translated for the Association by the Secretary and presented at the seventieth meeting, April 25, 1901.

THE ASSOCIATION SCHOLARSHIP.

At the Pan-American meeting held at Niagara Falls, Sept. 26, 1901, the offer of WILLIAM FIRTH, Esq., now a resident of Baycliffe, Lymm, Cheshire, England, to establish a scholarship on

behalf of the New England Cotton Manufacturers' Association at a textile school was accepted with the thanks of the Association.* He subsequently selected the New Bedford Textile School and gave to the Association the sum of $3,000 as a fund for establishing that scholarship. This money has been turned over to the Treasurer of the New Bedford Textile School, and the following deed of trust executed, to provide for its care and application:

DEED OF TRUST FOR THE SCHOLARSHIP AT THE NEW BEDFORD TEXTILE SCHOOL.

THIS INDENTURE by and between WILLIAM FIRTH of Boston, Massachusetts, the New England Cotton Manufacturers' Association, and the New Bedford Textile School, both corporations, organized under the laws of the Commonwealth of Massachusetts,

Witnesseth as follows, viz.:

Whereas the said WILLIAM FIRTH desires through the agency of the New England Cotton Manufacturers' Association to found and endow a scholarship in the New Bedford Textile School in such manner that sons of members, or deceased members of the New England Cotton Manufacturers' Association, may have the benefit of a technical education in textile methods of manufacture; and whereas the said New Bedford Textile School desires to accept said scholarship and to afford such education under the terms thereof:

Now Therefore:

I, the said WILLIAM FIRTH, do hereby pay over, transfer, and deliver to the said New Bedford Textile School through the agency of the New England Cotton Manufacturers' Association the sum of three thousand dollars ($3,000), the receipt whereof is hereby acknowledged by said New Bedford Textile School, to be held, managed, and controlled by said New Bedford Textile School as a Trust Fund, and strictly in trust for the following uses and purposes, and under the following terms and conditions, to wit:

First: Said fund shall be held in the name of the "New Bedford Textile School, Trustee," and shall be known as the "WILLIAM FIRTH Scholarship," and shall be in the custody of the Treasurer for the time being

*Transactions, Volume 71, page 94.

of the New Bedford Textile School, and shall by him be held distinct and separate from the general property and assets of said corporation. Such fund shall be invested in such safe and conservative securities as the Board of Directors for the time being of said New Bedford Textile School, or a committee thereof, shall determine, said Board of Directors to have the power to change said investments from time to time, and said Treasurer upon being duly authorized by vote of said Board of Directors, or a committee thereof, shall have the power to sell and transfer such securities, and in the name and behalf of said New Bedford Textile School, to sign and execute all necessary or proper instruments of transfer.

Second: A report by the Treasurer of the condition of said fund shall accompany the Treasurer's annual report of the School.

Third: The net income of said fund, after the payment of any necessary expenses of the management of said fund, but not including any compensation to said School, or any of its officers, for said management, shall be used and expended by the Treasurer under the direction of the Board of Directors, for defraying the expenses of a textile education at said School, including the tuition fees, and such necessary text books and supplies as said Board of Directors may determine, of a regular day scholar to be designated and selected as hereinafter provided.

Fourth: So much of the income of said fund as shall not be used as aforesaid shall be accumulated and added to said fund as a surplus to be used whenever the regular income shall be insufficient for the purposes of this fund.

Fifth: The beneficiaries of said scholarship shall be selected as follows, viz:

Applicants for said scholarship shall be the sons of members for the time being of the New England Cotton Manufacturers' Association, or of deceased members, and shall be designated and nominated by the Board of Government of said New England Cotton Manufacturers' Association, excepting that in default of any application from a son of a member or of a deceased member of the said New England Cotton Manufacturers' Association who is deemed by the Directors of the New Bedford Textile School as qualified to enter that institution, then the Board of Government of the said New England Cotton Manufacturers' Association may, at their discretion, nominate some other person to be the beneficiary of this scholarship.

Said applicants must comply with such reasonable regulations and

conditions as said New Bedford Textile School may from time to time adopt in relation thereto. From said applicants one shall be selected by the Directors of the New Bedford Textile School as the beneficiary of said scholarship.

Sixth: The New Bedford Textile School hereby accepts said fund and acknowledges the receipt thereof, and declares that it holds the same in accordance with the trusts herein set forth.

Seventh: The said New England Cotton Manufacturers' Association by its Board of Government hereby agrees to co-operate in furtherance of the undertakings contemplated by this indenture, and to make nominations according to the above provisions.

IN WITNESS WHEREOF, the said WILLIAM FIRTH has hereunto set his hand and seal, and the said New Bedford Textile School, by its President and Treasurer, hereto duly authorized, has caused its corporate name to be signed and its corporate seal to be affixed, and the said New England Cotton Manufacturers' Association, by its President and Secretary, duly authorized, has caused the same to be signed and its corporate seal affixed, this twentieth day of February, A. D., 1902.

L. S. WILLIAM FIRTH.

L. S. NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION.
By CHARLES H. FISH, *President.*
C. J. H. WOODBURY, *Secretary.*

L. S. NEW BEDFORD TEXTILE SCHOOL.
By ROBERT BURGESS, *President.*
ISAAC B. TOMPKINS, JR., *Treasurer.*

Immediately after the execution of the foregoing deed of trust, the Board of Government issued the following information to the membership and the press:

The donation of William Firth, Esq., has established a scholarship at the New Bedford Textile School primarily for the benefit of the son of a member or of a deceased member of the New England Cotton Manufacturers' Association, furnishing to the recipient of such scholarship, tuition, books and supplies for the course. Candidates for that scholarship will apply by letter only, addressed to the New England Cotton Manufacturers' Association, P. O. Box 3672, Boston, Mass. The candidates

must be at least fourteen years of age and furnish certificates of good moral character, and those who have been students of other technical institutions, colleges or universities will be required to furnish certificates of honorable dismissal from such institutions. Those applicants conforming to the above conditions will be nominated by the Board of Government to the New Bedford Textile School, and the selection of the candidate for the scholarship will be made as the result of an examination to be held in the lecture hall of the School at New Bedford, Mass., on Friday, September 12, 1902 at 10 A. M., or such other date as the Managing Director of the School may notify the candidates. Every candidate, previous to the entrance examination, must file an application at the School for admission, agreeing to observe the rules and regulations of the School. The courses of instruction for which candidates will be eligible are as follows: No. 1, the general Cotton Manufacturing course, which is a three years' course; No. 2, the Yarn Mill Superintendents' course, which is a one year's course; No. 3, the Weaving Mill Superintendents' course, which is a one year's course; No. 4, the Designers' course, which is a two years' course.

Candidates applying for the general Cotton Manufacturing course, No. 1, will have the preference over other candidates, as this is the most comprehensive of any of the courses in the School and is intended to give the student a general knowledge of all the cotton manufacturing processes, and sufficiently specific and complete information to qualify him to hold a position as superintendent of a cotton spinning and weaving mill, or other responsible post.

Any information not provided for in this circular, or conditions of enrollment not previously referred to, will follow the conditions as specified in the official catalogue of the New Bedford Textile School, which may be obtained on application to the Managing Director, New Bedford Textile School, New Bedford, Mass.

THE WHITNEY TABLET.

At the Pan-American meeting, the Association acted on the recommendation of the Board of Government approving of the proposition of Mr. M. F. FOSTER in a paper* which he read at the Montreal meeting by recommending the erection of a tablet to the memory of ELI WHITNEY on the house of the ELI WHITNEY Country Club to be built at Rocky Creek near Augusta, Ga., and the vote of the meeting authorized the Chair to appoint a committee of five to solicit subscriptions from the members and to attend to the matter of the installation of the tablet under the direction of the Board of Government. The subscriptions reached so nearly to the amount estimated for the purpose that the members of the committee individually guaranteed any deficiency, and the commission was given to Mr. CYRUS E. DALLIN, of Boston, an eminent sculptor who had received a gold medal for works at the World's Exposition at Paris in 1900, and was also a medallist at the Chicago Exhibition in 1893.

The tablet will bear a bronze alto relievo of ELI WHITNEY supported by bolls of cotton, and the following inscription:

A MEMORIAL TO
ELI WHITNEY,
FOR THE INVENTION OF THE
AMERICAN COTTON GIN,

A CONTRIBUTION TO THE RESOURCES
OF CIVILIZATION AND THE
MATERIAL WELFARE OF
THE UNITED STATES.

ERECTED BY
THE NEW ENGLAND COTTON
MANUFACTURERS' ASSOCIATION.

MDCCCCII

* Transactions New England Cotton Manufacturers' Association, Vol. 67, page 152.

At the lower left hand the seal of the Association forms a die, while on the corresponding right side of the tablet a similar disc contains a representation of the original model.

In order to provide for the continual care of this tablet as a public monument, its title has been vested in the care of a perpetual board of trustees under the provisions of the following:

DEED OF TRUST FOR THE MEMORIAL TABLET TO ELI WHITNEY AT THE ELI WHITNEY COUNTRY CLUB, ROCKY CREEK, GEORGIA.

The New England Cotton Manufacturers' Association, an organization duly incorporated by the Commonwealth of Massachusetts, desiring to perpetuate the memory of ELI WHITNEY, the Inventor of the American cotton gin, as a tribute to the great worth of this device and also in approval of the purposes of the Eli Whitney Country Club of Augusta, Georgia, an organization duly incorporated by the State of Georgia, have by a committee duly appointed for the purpose at a legal meeting of the said New England Cotton Manufacturers' Association held at Niagara Falls, New York, September 25 and 26, 1901, consisting of the following persons: M. F. FOSTER, *Chairman*, Milford, N. H., D. A. TOMPKINS, Charlotte, N. C., W. B. SMITH WHALEY, Columbia, S. C., CHARLES H. FISH, Dover, N. H., and C. J. H. WOODBURY, *Secretary*, Lynn, Mass., caused to be made a certain bronze memorial tablet with suitable inscriptions, to be placed upon the house to be erected by the said Eli Whitney Country Club at Rocky Creek, near Augusta, Georgia, and for the purpose of holding the said tablet in perpetuity, its title is vested in the following Trustees: His Honor JACOB PHINIZY, the Mayor of the city of Augusta, Georgia; The Honorable ALEXANDER R. WALTON, Ordinary of Richmond County, Georgia; The Honorable WILLIAM F. EVE, Judge of the City Court, Richmond County, Georgia; and their successors in the several offices shall *ex officiis* occupy their positions as these members of the Board of Trustees. This deed of trust confers on the above Trustees and their successors the powers and immunities conferred upon trustees under the law and without prejudice to the above, the following powers and immunities, they shall keep the said tablet on the building of the said Eli Whitney Country Club as long as may be desired by that corporation if it continues its existence as an active organization devoted, among other purposes, to the perpetuation of the memory of ELI WHITNEY, but if the said Eli Whitney Country

Club shall cease to maintain its active organization from any cause whatsoever, then the said Trustees shall cause said tablet to be removed from the said Club building and placed in some public building or position they may direct in the City of Augusta, Georgia. Furthermore, the Trustees are relieved from all personal responsibility, in case of the damage of this tablet by fire or from other cause and they are endowed with the full privilege of their discretion in administering the above conditions of the trust according to their own judgment.

In witness whereof the said New England Cotton Manufacturers' Association by its President and Secretary, duly authorized, have caused the same to be signed and its corporate seal affixed, and the said Eli Whitney Country Club, by its President and Secretary, duly authorized, have caused the same to be signed and its corporate seal affixed, and the said Trustees as above mentioned have signed and sealed this instrument in acceptation of the said trust this the nineteenth day of April, A. D. 1902.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
L. S. By CHARLES H. FISH, *President.*
C. J. H. WOODBURY, *Secretary.*

ELI WHITNEY COUNTRY CLUB,
L. S. By JAMES F. MCGOWAN, *President.*
T. C. CRAWFORD, *Secretary.*

L. S. JACOB PHINIZY,
Mayor of Augusta, Georgia.
L. S. ALEXANDER R. WALTON,
Ordinary of Richmond County, Georgia.
L. S. WILLIAM F. EVE,
Judge of City Court, Richmond County, Georgia.
} TRUSTEES.

INDEX TO TRANSACTIONS.

During the past year the card catalogue of the 71 volumes of Transactions has been nearly brought to completion. This has involved extra clerical service without expense to the Association. The usefulness of this index, which enables one to obtain at once the reference either to subject, title or speaker and also the name of each member ever elected to the Association, as well as of the present members, will be of greater value as time goes on. Most of the visitors to the office are those who come

for the purpose of looking up some matter in the Transactions. The number of cards used is about 8,400, and the Transactions for the present year will probably increase it to above the 9,000 originally estimated.

An application of the card catalogue will be made in the next volume of the Transactions where citations of former papers treating of the subject will appear as a foot note to each paper. References to earlier states of the art will have an interest and in some instances a value in comparison with the modern treatment of a subject.

In this connection an effort has been made to complete the necrology of past members, and the co-operation of the members is especially asked in connection with the proof sheets which have been sent to the membership to furnish to the Association before the publication of the list in a future volume of Transactions such information as they are able to supply of dates of missing decease.

MEMBERSHIP.

During the past year the following members have died: DANIEL J. GILLIGAN, STEPHEN GREENE, EFFINGHAM C. HAIGHT, SHELDON S. SPENCER, HERBERT R. FARNUM, ALBERT KNIGHT and JOSEPH WARREN WATTLES; biographical sketches of whom will appear in the volumes of Transactions for the year.

At the beginning of the fiscal year, the membership of the Association was 614 which has been increased by the election of 52 at the two meetings. This number has been diminished by seven deaths, ten resignations, three instances of lapsed dues and two who failed to confirm their elections, leaving a net membership of 644 in advance of this meeting.

The Board of Government has held six meetings during the year, in addition to which there have been numerous meetings of sub-committees.

The following table shows the membership of the Association at various meetings since its foundation in April, 1865, the number elected and the number of present members:

MEMBERSHIP OF THE ASSOCIATION.

Number of Meeting.	DATE OF MEETING.	Membership.	Number of Present Members	Number Elected to Membership.
1	Apr. 20, 1865, Boston, Mass.	44	7	44
	July 19, 1865, Adj. Meeting,	—	3	42
2	July 18, 1866, Boston, Mass.	72	0	0
3	July 17, 1867, " "	—	1	10
4	Jan. 15, 1868, " "	108	1	32
5	July 15, 1868, " "	—	1	12
	Oct. 21, 1868, Adj. Meeting,	—	2	6
6	Apr. 21, 1869, Boston, Mass.	—	2	19
7	Oct. 20, 1869, " "	—	1	8
8	Apr. 20, 1870, " "	144	1	12
9	Oct. 19, 1870, " "	—	0	5
10	Apr. 19, 1871, " "	—	2	9
11	Oct. 18, 1871, " "	—	1	16
12	Apr. 17, 1872, " "	166	4	29
13	Oct. 16, 1872, " "	—	3	14
14	Apr. 16, 1873, " "	175	1	13
15	Oct. 15, 1873, " "	—	5	17
16	Apr. 15, 1874, " "	189	1	13
17	Oct. 21, 1874, " "	—	0	7
18	Apr. 21, 1875, " "	199	3	13
19	Oct. 27, 1875, " "	—	2	18
20	Apr. 26, 1876, " "	200	1	11
21	Oct. 25, 1876, " "	—	1	13
22	Apr. 25, 1877, " "	213	4	20
23	Oct. 31, 1877, " "	—	2	9
24	Apr. 24, 1878, " "	210	6	8
25	Oct. 30, 1878, " "	—	3	11
26	Apr. 30, 1879, " "	205	3	10
27	Oct. 29, 1879, " "	—	6	16
28	Apr. 28, 1880, " "	219	2	14
29	Oct. 27, 1880, " "	—	3	13
30	Apr. 27, 1881, " "	231	2	11
31	Nov. 30, 1881, " "	—	2	6
32	Apr. 26, 1882, " "	231	2	9
33	Oct. 25, 1882, " "	—	3	5
34	Apr. 25, 1883, " "	240	4	15
35	Oct. 31, 1883, " "	—	4	10
36	Apr. 30, 1884, " "	247	4	9
37	Oct. 29, 1884, " "	—	2	2
38	Apr. 29, 1885, " "	225	3	3
39	Oct. 28, 1885, " "	—	5	8
40	Apr. 28, 1886, " "	225	4	7
41	Oct. 27, 1886, " "	—	6	8

Number of Meeting.	DATE OF MEETING.	Membership.	Number of Present Members	Number Elected to Membership.
42	Apr. 27, 1887, Boston, Mass.	234	4	10
43	Oct. 27, 1887, " "	——	2	3
44	Apr. 25, 1888, " "	241	10	15
45	Oct. 31, 1888, " "	——	7	12
46	Apr. 24, 1889, " "	242	4	6
47	Oct. 30, 1889, " "	——	4	8
48	Apr. 30, 1890, " "	246	5	7
49	Oct. 29, 1890, " "	——	9	11
50	Apr. 29, 1891, " "	254	3	4
51	Oct. 28, 1891, " "	——	5	8
52	Apr. 27, 1892, " "	244	11	12
53	Oct. 26, 1892, " "	——	15	19
54	Apr. 26, 1893, " "	259	5	11
55	Oct. 25, 1893, " "	——	8	9
56	Apr. 25, 1894, " "	270	11	16
57	Sept. 27—28, 1894, Crawford House, N. H.	292	14	19
58	Apr. 24—25, 1895, Providence, R. I.	383	71	92
59	Oct. 24—25, 1895, Atlanta, Ga.	422	35	46
60	Apr. 29—30, 1896, Boston, Mass.	450	21	29
61	Sept. 22—24, 1896, Profile House, N. H.	459	18	19
62	Apr. 28—29, 1897, Boston, Mass.	495	37	43
63	Oct. 27—28, 1897, Philadelphia, Pa.	523	31	38
64	Apr. 27—28, 1898, Boston, Mass.	535	19	24
65	Sept. 27—29, 1898, Crawford House, N. H.	554	13	16
66	Apr. 26—27, 1899, Boston, Mass.	564	28	33
67	Oct. 5— 6, 1899, Montreal, P. Q.	580	20	22
68	Apr. 25—26, 1900, Boston, Mass.	603	35	38
69	Oct. 16—18, 1900, Washington, D. C.	628	36	38
70	Apr. 24—25, 1901, Boston, Mass.	647	32	33
71	Sept. 25—26, 1901, Niagara Falls, N. Y.	661	18	19
72	Apr. 23—24, 1902, Boston, Mass.	681	42	42

The headquarters of the Association have been well patronized by members during the year and the bound volumes of the Transactions and also the books of reference and technical papers have been frequently consulted by those without the Association as well as by its members. The rooms have been called into frequent use by members for various business conferences during the year.

As the office copies of the Transactions of the Association were destroyed by fire February 2, 1890, there is a demand for

copies earlier than that date, particularly on the part of the libraries of technical institutions, and the Secretary would like information of any earlier copies which may be for sale.

The following diagram represents in a graphical manner the growth of the Association from its formation.

During the past year the United States Census Bureau, by the courtesy of S. N. D. NORTH, Esq., Chief Statistician of Manufactures, has sent to each member of the Association a monograph on cotton ginning.

The Transactions of the following societies and periodicals are sent to the Association and kept on file.

TRANSACTIONS OF TECHNICAL SOCIETIES.

American Society of Civil Engineers,	New York.
American Society of Mech. Engineers,	New York.
American Institution of Elect. Engineers,	New York.

Boston Chamber of Commerce,	Boston.
Bureau of the American Republics,	Washington, D. C.
Consular Reports, Bureau of Statistics,	Washington, D. C.
National Association of Wool M'f'rs.,	Boston.
National Electric Light Ass'n.,	New York.
Western Society of Civil Engineers,	Chicago.

LIST OF PERIODICALS KEPT ON FILE.

American Wool and Cotton Reporter,	Boston.
Boston Journal of Commerce,	Boston.
Cassier's Magazine,	New York.
Cotton,	Atlanta.
Dry Goods Economist,	New York.
Electrical Review,	New York.
Engineering Record,	New York.
Fibre and Fabric,	Boston.
Iron Age,	New York.
Manufacturers' Record,	Baltimore.
Mill and Shop,	Boston.
New England Shoe and Leather Association Monthly Gazette,	Boston.
Power,	New York.
Power and Transmission,	Mishawaka, Ind.
Protectionist,	Boston.
Steam Engineering,	New York.
Textile Manufacturers' Journal,	New York.
Textile Recorder,	Manchester, Eng.
Textile Record of America,	Philadelphia.
Textile World,	Boston.

Respectfully submitted,

C. J. H. WOODBURY,

Secretary.

April 4, 1902.

On motion of Mr. M. F. FOSTER, duly seconded, it was voted that the report of the secretary be accepted.

TREASURER'S REPORT.

C. J. H. WOODBURY, TREASURER, IN ACCOUNT WITH THE NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION.

April 1, 1901 to April 1, 1902.

DEBTORS.

Cash,	$452 96	
Active membership dues,	2,510 00	
Associate membership dues,	1,410 00	
Active admission fees,	340 00	
Associate admission fees,	475 00	
Interest,	67 70	
Sale of Transactions,	30 55	
Advertising,	1,220 00	
Medal and Certificate Fund,	1,000 00	
Engraving,	5 78	
Miscellaneous,	20	
Students' Medal Fund,	200 00	
Whitney Tablet Fund,	665 00	
New England Cotton Manufacturers' Association Scholarship, donation of Wm. Firth,	3,000 00	
Total,		$11,377 19

CREDITORS.

Board of Government,	$106 73	
Office rent,	399 96	
Secretary and Treasurer,	1,475 00	
Amount forward,		$1,981 69

Amount forward,	$1,981 69	
Reports of meetings,	112 50	
Notices and stationery,	271 56	
Meeting expenses,	154 74	
Printing and distributing Transactions,	1,974 90	
Badges,	97 55	
Stenographer and proof,	547 49	
Postoffice box,	10 20	
Advance copies of papers,	359 40	
Engraving,	188 30	
Miscellaneous,	37 48	
Postage, telegrams and express,	77 81	
Office supplies and furniture,	83 58	
Medal and Certificate Fund,	68 22	
New Bedford Textile School Scholarship Fund,	3,000 00	
Whitney Tablet,	45 56	
Re-printing Vol. 56, Transactions,	93 35	
Securities and cash,	2,272 86	
Total,		$11,377 19

AUDITOR'S REPORT.

I hereby certify that the amounts from April 1, 1901, to April 1, 1902, are correctly cast, that all payments are properly vouched for, that the funds are kept on deposit in the name of the New England Cotton Manufacturers' Association, and that the amount of the deposit April 1, 1902, agrees with the balance in the books, viz., $1,072.86.

The securities in which the Association funds have been invested have been examined.

C. E. ROBERTS,
Auditor.

BOSTON, MASS., April 4, 1902.

The earnings of the Association for the year may be placed as:

515 active members at $5.00,	$2,575 00	
142 associate members at $10.00,	1,420 00	
36 active admissions at $10.00,	360 00	
15 associate admissions at $25.00,	375 00	
Advertising,	1,215 00	
Miscellaneous,	119 03	
Total,		$6,064 03

The payments by the Treasurer were $6,104 33, and these are subject to a deduction of $68 49 for payments which will be reimbursed to the Association for the Whitney tablet and electrotypes, leaving the actual expenses of the organization $6,035 84.

The bills receivable are:

Active dues,	$270 00	
Associate dues,	190 00	
Transactions,	3 00	
Advertisements,	140 00	
Miscellaneous,	20 55	
Total,		$623 55

There are no bills payable, unless the amount held in trust for the incomplete Whitney tablet be so considered.

The income derived from advertisements has enabled the Association to be conducted on the same basis as other technical organizations which are supported by higher assessments as well as by advertisements in their transactions. The amounts from this source have amounted in the several volumes of the Transactions to:

63	Philadelphia, October, 1897,	$385 00
64	Boston, April, 1898,	420 00
65	Crawford House, September, 1898,	450 00
66	Boston, April, 1899,	550 00
67	Montreal, October, 1899,	445 00
68	Boston, April, 1900,	580 00
69	Washington, October, 1900,	665 00
70	Boston, April, 1901,	620 00
71	Pan-American, September, 1901,	595 00
72	Boston, April, 1902, (already under contract),	495 00

The following table presents the finances of the Association for the past twelve years:

MEMBERSHIP.			TRANSACTIONS.			FINANCES.				
Fiscal Year Ending April 1.	Enrollment.	Members Elected.	Volume Number.	Pages in Volume.	Pages for Year.	Cash Receipts.	Expenses.	Cost per Page of Transactions.	Cost per Member.	Cost per Page of Transactions for each member Cents.
1891	246	18	48 49	43 62	105	$1,142 00	$ 926 08	$8 82	$3 76	3.59
1892	254	12	50 51	129 60	189	1,260 68	1,374 46	7 27	5 41	2.86
1893	244	31	52 53	63 94	157	1,678 33	1,603 25	12 22	6 57	6.33
1894	259	19	54 55	84 86	170	1,414 58	1,807 60	10 63	7 03	4.14
1895	270 292	35	56 57	73 230	303	1,947 07	1,957 64	6 46	6 71	2.21
1896	383 422	142	58 59	310 327	637	4,579 19	3,636 31	5 71	8 59	1.34
1897	450 459	49	60 61	269 359	628	3,710 02	3,980 34	6 33	8 67	1.43
1898	495 523	83	62 63	353 453	806	4,717 08	4,333 85	5 38	8 28	1.18
1899	535 554	42	64 65	321 380	701	4,713 56	4,775 97	6 81	8 62	1.23
1900	564 580	56	66 67	464 296	760	5,237 53	5,007 23	6 57	8 63	1.14
1901	603 628	78	68 69	382 476	858	6,331 93	6,295 55	7 34	10 02	1.16
1902	647 661	52	70 71	366 379	745	6,724 23	6,035 84	8 10	9 13	1.22

April 4, 1902.

Respectfully submitted,

C. J. H. WOODBURY,

Secretary and Treasurer.

On motion of Mr. M. F. FOSTER, duly seconded, it was voted that the report of the treasurer be accepted.

AWARD OF THE ASSOCIATION MEDAL.

The PRESIDENT. Mr. ALFRED E. ADAMS will present a report on behalf of the Board of Government.

Mr. ALFRED E. ADAMS. The Board of Government, after examining the Transactions and the rule upon which the award of the Association Medal was to be based, have awarded the medal first, to CHARLES H. FISH of Dover, N. H., for his contributions upon the drying of textile fabrics as contained in the following papers:

The Possibilities of a New Method for Drying Textile Fabrics, vol. 65, p. 226.

The Practical Results Obtained in the Drying of Textile Fabrics with the Assistance of a Vacuum, vol. 67, p. 212.

The Use of Stationary "Cells" in Place of Rotating Cylinders in the Drying of Textile Fabrics, vol. 69, p. 212.

These papers describe both the invention of machinery and a novel process in which the economy of floor space is reduced nearly seven-eighths, the repairs to the machinery are reduced to almost nothing by the entire absence of moving parts of steam tight connections, and the goods are better handled by reason of the process being carried on at a lower temperature.

I now have the pleasure of presenting to our president, Mr. CHARLES H. FISH, the Association medal. [Applause.]

The PRESIDENT. Gentlemen, I am in a rather embarrassing position. I wish to assure you all that I had nothing whatever to do with this award; in fact, I knew nothing at all about it, except that the committee had the matter in hand. I thank you sir, most heartily. [Applause.]

Mr. ALFRED E. ADAMS. The Board of Government also award an Association medal to SIDNEY B. PAINE of Boston,

AND COTTON MANUFACTURERS ASSOCIATION
ANNO JUNCTIM MIN

Mass., for his paper on The Electrical Driving of Textile Establishments, vol. 58, p. 216 of the Transactions, and in this connection they also wish to recognize the value to mills of Mr. PAINE'S engineering skill in the practical development of the electrical transmission of power.

I now have the pleasure of presenting to Mr. SIDNEY B. PAINE the Association medal. [Applause.]

Mr. SIDNEY B. PAINE. Mr. President and gentlemen, it is with deep appreciation that I accept this evidence of your approval of the work upon which I have been engaged for the last ten years. But I cannot regard it as entirely personal, for your Association collectively, and many of your members individually, have not only encouraged me in this work, but have actively assisted in the development of the electric drive. I therefore feel that while I may be the honored custodian of this beautiful token, it really belongs to you all, for without your sympathy and your assistance and your support, the results which have been achieved would at least have been long delayed. The electric drive is truly a child of this Association. I desire, however, to acknowledge my own indebtedness to you collectively and individually. [Applause.]

The following papers were read:

Methods of Cotton Textile Instruction.
W. W. CROSBY, Lowell, Mass.

Discussed by Mr. ARTHUR H. LOWE.

Brick Factory Chimneys: Some Features of their Construction.
WILLIAM WALLACE CHRISTIE, C. E., Paterson, N. J.

Discussed by Mr. SANFORD E. LORING.

The PRESIDENT. The business of this session is finished and I declare a recess until two o'clock this afternoon. I trust that the members will be prompt, as the use of the stereopticon in

illustrating the first paper at that session will require that the room be darkened.

We have received several courtesies from various parties at this meeting, and I appoint as a committee on resolutions to consider the matter Messrs. ARTHUR H. GULLIVER, CHARLES A. DENNY and ROBERT STEWART.

SECOND SESSION.

WEDNESDAY AFTERNOON, APRIL 23, 1902.

Meeting called to order at 2 P. M., President FISH in the chair.

The PRESIDENT. Gentlemen, if you will be seated, please, the secretary has some notices to give.

The SECRETARY. Mr. President, I have received the following telegram:

CHARLOTTE, N. C.,
April 23, 1902.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

The Southern Cotton Spinners' Association extend their compliments and wish you a most harmonious and successful convention.

C. B. BRYANT,
Secretary and Treasurer.

The Board of Government, in accordance with their custom of sending an official invitation to attend the meeting to all persons who are candidates for election to membership, have also included various persons in different localities who have in times past extended courtesies to the Association at its meetings, and I will read a few of their replies:

DEAR MR. WOODBURY:

I thank the President and Directors of the New England Cotton Manufacturers' Association for their invitation to be present at the meeting. An engagement out of Boston will prevent my attendance, but I should, if it had been possible, have been very glad to attend some of the meetings.

Very truly yours,

F. P. FISH.

Mr. BRYANT of the Southern Cotton Spinners' Association, whose telegram I read, sent a very cordial letter. Gen. THOMAS SHERWIN, president of the New England Telephone and Telegraph Company, the corporation which has put two telephone booths at our service in the entry, expects to be present at some of the sessions. Col. CARROLL D. WRIGHT, who discoursed so wisely at the Washington meeting, felt that there was a possibility of his being at Boston at this time, and if so he should attend the meeting. You all remember the Manufacturers' Club of Philadelphia, and Mr. FAYETTE R. PLUMB acknowledges with many kind words the invitation. Mr. O. P. AUSTIN, the statistician of the Treasury Department, desires to accept the invitation, but he is unable to be present. The Secretary of the Boston Chamber of Commerce also sends regrets. Mr. CHARLES T. GALLAGHER, President of the Boston Art Club, is engaged in court, being a lawyer, and will not be able to be present.

In that connection I will remind you of the statement on the programme announcing the 66th exhibition at the Boston Art Club, an exhibition of water colors, etc. I happen to be a member and have made arrangements for a number of tickets, admitting bearer and friends, including ladies, and shall be glad to distribute them.

Mr. CHARLES S. HAMLIN, ex-Assistant Secretary of the Treasury, writes that it would give him great pleasure to be present, and Professor MILLER, now principal of the Philadelphia Textile School sends regrets. Mr. WESTINGHOUSE regrets that previous engagements prevent his acceptance of the invitation,

but the Nernst lamp, which will be exhibited at this time to-morrow, is presented here at the instance of Mr. WESTINGHOUSE. Our friend, Mr. R. H. EDMUNDS of the Manufacturers' Record of Baltimore, has just returned from Mexico and will not be able to be present. We have a great many other replies, but on account of the lateness of the hour, I will reserve them, if you please, Mr. President, awaiting another opportunity during the meeting.

The following papers were read:

Hydraulic Compression of Air.
(Illustrated by the Stereopticon.)
W. O WEBBER, C. E., Boston, Mass.

Discussed by Mr. WILLIAM D. HARTSHORNE.

Flyers.
FAY H. MARTIN, Boston, Mass.

Knots and Knot Tying.
ROBERT C. WEBSTER, Boston, Mass.

Thread Boards and Guides for Wet Twisting.
LEWIS T. HOUGHTON, Worcester, Mass.

The Whittum Metallic Thread Board.
RICHARD THACKERAY, Fall River, Mass.

THIRD SESSION.

THURSDAY MORNING, APRIL 24, 1902.

Meeting called to order at 10 A. M., the President in the chair.

The following papers were read:

A New Combing Machine.
JOSEPH NASMITH, Manchester, England.

Read by the Secretary in the absence of the author.

An Electrically Driven Cotton Mill.
JOHN O. DEWOLF, Boston, Mass.

The Electric Drive for Cotton Mills.
W. B. SMITH WHALEY, Columbia, S. C.

Discussed by Messrs. JOHN E. PREST, W. B. SMITH WHALEY, ARTHUR H. GULLIVER, CHARLES H. FISH, WILLIAM L. LYALL, HOLLON C. SPAULDING and SIDNEY P. PAINE.

The PRESIDENT. I wish to announce that Mr. HENRY HIGSON of Blackburn, England, Chairman of the Lancashire Manufacturers' Association, is expected here this afternoon with a delegation of cotton manufacturers from England. Some of our members have now gone to the dock as a committee of which I have appointed Mr. C. P. BROOKS as chairman to meet the steamer, which is expected this morning, and to extend to

them our welcome and a cordial invitation to attend our meetings.

The SECRETARY. The paper this afternoon will require that the room shall be darkened, but before that we expect to receive the report of the committee on nominations and the ballots for officers, so it will be desirable if as many of the gentlemen as can will be here by two o'clock. Mr. WESTINGHOUSE has been to a great deal of expense and trouble to make this exhibit as full and complete an exposition as possible of the new method of electric lighting, especially in its application to mill work and to the needs of mills. Before the Pan-American Exposition he sent me a personal invitation to introduce myself to his company's exhibit when I went to Buffalo, and I did so, and was so pleased with what I saw and the manner in which it was explained by their representative that the matter was brought before the Board of Government and they went outside of all of the precedents and methods of this Association to allow a displayed exhibit at one of our meetings, and it is hoped that the results will be such that the members will justify the Board of Government in their action.

The PRESIDENT. Mr. GULLIVER has some resolutions to present at this time.

Mr. ARTHUR H. GULLIVER offered the following resolutions, which on motion, duly seconded, were unanimously adopted:

Mr. ARTHUR H. GULLIVER. Mr. President, your committee would report the following resolutions:

Resolved, that the thanks of the Association be extended to His Honor, PATRICK A. COLLINS, Mayor of the City of Boston, for his cordial greeting and welcome to this city, and for his hearty interest in our Association and work.

To SAMUEL T. HUBBARD, President New York Cotton Exchange, whose kindness we recognize in coming to this Association and giving us so able a speech, which all of the members thoroughly appreciate.

To the New England Telephone and Telegraph Company, for the courtesy of their lines to our members during the sessions of the Association, and in this connection we wish to place on record the excellent character of their telephone service.

To the American Telephone and Telegraph Company, for their courtesy in granting the free use of their lines to our members during the sessions of the Association, and we take this opportunity of expressing the great extension of business facilities of the message and its instantaneous answer which is afforded by the long distance telephone.

To W. W. CROSBY, of the Lowell Textile School, for his very interesting description of the work of textile instruction, which has been so successfully carried out, and so advantageous to all his pupils.

To WILLIAM WALLACE CHRISTIE, of Paterson, N. J., for his very interesting address on the subject of Brick Factory Chimneys.

To W. O. WEBBER, C. E., of Boston, Mass. for his illustrated lecture so thoroughly given on the Hydraulic Compression of Air.

To JOSEPH NASMITH, of Manchester, England, for his address on the advantageous features of the new combing machine which has been submitted.

To MURRAY C. BEEBE, of Pittsburg, Pa., for his carefully illustrated lecture showing the advantageous use of the Nernst lamp in Industrial Establishments.

To the Nernst Lamp Company, of Pittsburg, Pa., for their courtesy in exhibiting to the Association the illumination and methods of construction of the Nernst lamp.

To CHARLES N. WAITE, of Philadelphia, for his very able paper on Viscose, as Applied to Textiles.

To TETSUTARO INUMARU, of Tokio, Japan, for his most interesting description giving statistics of Japanese Cotton Mills, which has been so satisfactorily portrayed.

INTERSTATE COMMERCE.

Mr. B. B. COMER. Mr. President, we have just adopted a resolution of thanks to Mr. SAMUEL T. HUBBARD, president of the New York Cotton Exchange, for his able address. But now if you remember, Mr. President, one of the principal points of that address was a statement as to the troubles we have with interstate commerce and the discrimination in freight rates. He

stated, as you remember, that he had just appeared on behalf of the New York Cotton Exchange before a committee of Congress asking the passage of a bill to give the Interstate Commerce Commission more power. It is customary for this Association to take cognizance of such situations as that. It seems to me the very point of that address was to bring the matter before this Association, to the end that we should send a petition to Congress requesting them to pass the bill to increase the power of the Interstate Commerce Commission in order that there should be a Federal control of rates. I don't know whether that should come before this body or not. That rates are becoming disorganized we all know; that they are being so arranged that different parties are hurt, we all know. But now, as I say, the question before us is to decide whether it is within the province of this body to petition Congress in that line, to give the Interstate Commerce Commission more power. As I take it, that was the very pith of Mr. HUBBARD'S address yesterday.

The PRESIDENT. My impression is that that matter had best come before the Board of Government and perhaps it could be submitted to the Association at a later meeting. I agree with you that Mr. HUBBARD'S address evidently pointed strongly in that direction. I think it is perhaps within the province of this Association to take action at this time, but I would suggest that that matter be left to the Board of Government to get further information and to perhaps act later on the subject. If there are any further remarks on that particular point I should be glad to hear them. Mr. HUBBARD certainly gave us much food for reflection. Some of his statements, I confess, were new to me and I think were new to the majority of the members of the Association, regarding the condition of the freight rates from the South.

Mr. B. B. COMER. Yes, his statement was that the rate from the Southwest, for instance, to Liverpool, was practically less

than it is to New England points. That is interstate commerce. What we need is to have authority given the Interstate Commerce Commission to regulate such a matter. To show you the application of state laws to transportation within a state, in Alabama we have a railroad commission of the very smallest power, and yet within the last few months it has cut the rate on coal in the state to the cotton mills of the state perhaps 30 per cent. — the freight on coal from the mines of the state to the different cotton mills of the state. This rate of 28 cents from New Orleans to Liverpool and of 30 cents from New Orleans to Boston, perhaps, or Fall River — that is what hurts New York, and that is why New York kicks; I mean the New York Cotton Exchange — because they want it to come through New York. But what we want to know is whether this Association will take cognizance of what Congress is doing in that line, — whether we should have an interstate commerce commission with power or without power. That is the point I want to bring out.

The PRESIDENT. Has any one any suggestion to make on that question? Personally I do not consider that I am free to answer the question for the Association. I think it is a matter that requires, and without doubt, will receive, attention. Just how we had best proceed in a matter I should like suggestions on, if any one has any to give.

Mr. B. B. COMER. Another reason I had for asking the question, Mr. President, was that I lately attended a meeting of the Manufacturers' Convention in Indianapolis, and being a new man there, it struck me that one of the principal things they had accomplished was influencing favorable legislation. It struck me that was one of the main points of their meeting. I am not sure that that is the fact, but that is the way it impressed me. I did not know whether this Association was similarly constructed or not.

The PRESIDENT. No, sir, I would answer that; I do not think it is constructed that way. Heretofore I do not think that

any precedent has been established whereby we would be expected to take up this matter in convention, if I understand it rightly.

Mr. JAMES P. TOLMAN. Mr. President, I trust that in this matter we may adhere to our traditions and regard this as an association whose purpose shall be with reference to the operation of the mill and not with reference to the operation of politics. We cannot enter upon that scheme of instructing our representatives in Congress, and I trust that we shall remain an operative body.

The PRESIDENT. Well, sir, I think that has been the idea of the Association. Personally I do not think it is within our province, or at least we have no precedent which would allow us to take action at this time.

FOURTH SESSION.

THURSDAY AFTERNOON, APRIL 24, 1902.

Meeting called to order at 2 P. M., President FISH in the chair.

ELECTION OF MEMBERS.

The PRESIDENT. The first business of the afternoon session is the election of members. The Board of Government have submitted the following list of candidates with their approval.

FOR ACTIVE MEMBERSHIP.

C. ENOS BEAN, Supt. Millville Mfg. Co., Millville, N. J.
By Mr. A. W. BRAINERD.

WILLIAM H. BILBROUGH, Mgr. Elmira Knitting Mills and Mgr. Conewawah Spinning Co., Elmira, N. Y.
By Mr. D. W. GRAY.

GEORGE T. BRIGGS, Vice Pres. and Gen. Mgr., The Briggs Mfg. Co., Voluntown, Conn.
By Mr. J. O. SWEET.

LYMAN M. COUSENS, Pres. Dana Warp Mills, Portland, Me.
By Mr. WOODBURY K. DANA.

RICHARD COWELL, Supt. Boott Cotton Mills, 25 Read St., Lowell, Mass.
By Mr. N. B. KERR.

HARRY K. DREW, Supt. Clinton Mfg. Co., Woonsocket, R. I.
By Mr. GEO. E. SPOFFORD.

FRANK J. DUTCHER, Pres. Shaw Stocking Co., Hopedale, Mass.
By Mr. GEORGE A. DRAPER.

D. A. EVERLY, Cotton Mfr., Pawtucket, R. I.
By Mr. JAS. R. MACCOLL.

OTTO GOETZE, Partner and Gen. Mgr. Glasgow Mills, Philadelphia, Pa.
By Mr. ALFRED H. BURNHAM.

ERNEST L. HILL, Vice Pres. Renfrew Mfg. Co., 320 Broadway, N. Y. City.
By Mr. CHARLES H. FISH.

WILLIAM H. HILL, Pres. Windsor Co. and Pres. Renfrew Mfg. Co., 40 Water St., Boston, Mass.
By Mr. CHARLES H. FISH.

WILLIAM HENRY HOBBS, Asst. Supt. Johnson & Johnson Co., New Brunswick, N. J.
By Mr. ALBERT H. MORTON.

EDWARD W. HOUGHTON, Supt. Globe Mill, Woonsocket, R. I.
By Mr. CHARLES H. MERRIMAN, Jr.

WILLIAM N. KIMBALL, Supt. Social and Nourse Mills, Manville Co., Woonsocket, R. I.
By Mr. EARL A. THISSELL.

EMIL KIPPER, Treas. Renfrew Mfg. Co. and Windsor Print Works, Adams, Mass.
By Mr. Z. D. HALL.

CALVIN H. LEE, Supt. Readville Cotton Mills, Hyde Park, Mass.
By Mr. GEORGE E. SPOFFORD.

CHARLES F. LIBBY, Supt. Shaw Stocking Co., Lowell, Mass.
By Mr. WILLIAM E. HALL.

JOSEPH MERCER, Agt. and Treas. Willimantic Cotton Mills Co., Willimantic, Conn.
By Mr. JOHN ECCLES.

GEORGE B. MORISON, Pres. Ballou Yarn Co., 78 Chauncy St., Boston, Mass.
By Mr. EDWARD R. BALLOU.

GEORGE E. PREST, Supt. No. 1 Harmony Mill, Cohoes, N. Y.
By Mr. J. E. PREST.

HARRY B. PREST, Asst. Supt. Harmony Mills, Cohoes, N. Y.
By Mr. J. E. PREST.

JOHN W. RAMSBOTTOM, Supt. Samoset Co., Valley Falls, R. I.
By Mr. JAMES R. MACCOLL.

JOHN BION RICHARDS, Treas. Davis Mill, Fall River, Mass.
By Mr. EDWIN BARNES.

WILLIAM H. ROBINSON, Supt. No. 3 Harmony Mill. Cohoes, N. Y.
By Mr. J. E. PREST.

ALFRED SAGAR, Supt. Arlington Cotton Mills, 15 High St., Methuen, Mass.
By Mr. L. E. BARNES.

RICHARD W. B. SANDERSON, of G. S. Lings & Co., Yarn Merchants, P. O. Box 1323, Providence, R. I.
By Mr. JAMES R. MACCOLL.

ALBION K. SEARLS, Supt. Ogden Mill (Harmony Mills), Cohoes, N. Y.
By Mr. J. E. PREST.

ALPHONSO F. WHITE, Supt. Forestdale Mfg. Co., Forestdale, R. I.
By Mr. CHARLES E. THOMAS.

GEORGE A. WIES, Treas. Eureka Fire Hose Co., 13 Barclay St., New York City.
By Mr. B. L. STOWE.

WILLIAM E. WINCHESTER, Teacher of Cotton Carding and Spinning, Philadelphia Textile School, Broad and Pine Sts., Philadelphia, Pa.
By Mr. EDWARD W. FRANCE.

FOR ASSOCIATE MEMBERSHIP.

SAMUEL M. GREEN, Holyoke, Mass.
By Mr. WILLIAM H. STRATTON.

EDWIN FARNHAM GREENE, Pres. Lockwood, Greene & Co., 93 Federal St., Boston, Mass.
By Mr. CHARLES H. FISH.

FREDERIC W. HOWE, Selling Agent, Crompton & Knowles Loom Works, Box 899., Providence, R. I.
By Mr. CHARLES H. CHILD.

DANIEL JACKSON, Cotton Buyer, B. B. & R. Knight, Providence, R. I.
By Mr. CHARLES M. HOLMES.

SANFORD E. LORING, Consulting Architect, 104 Everson Building, Syracuse, N. Y.
By Mr. STEPHEN MINOT PITMAN.

PERCY H. DE MAURIAC, Cotton Yarn Commission Merchant, 78 Chauncy Street, Boston, Mass.
By Mr. J. R. MONTGOMERY.

ROBERT W. NEFF, Chemical Mfr., 22 India Sq., Boston, Mass.
By Mr. A. C. FREEMAN.

WILLIAM F. PARISH, Jr., Engineer, Vacuum Oil Co. (Technical Department), 101 Milk St., Boston, Mass.
By Mr. RICHARD THACKERAY.

WILLIAM N. SHAW, Treas. The Geo. W. Stafford Co., Readville, Mass.
By Mr. GEORGE W. STAFFORD.

GEORGE C. TEWKSBURY, Eastern Mgr. The Underfeed Stoker Co. of America, 721 Exchange Building, Boston, Mass.
By Mr. H. G. BRINCKERHOFF.

J. F. WARREN, Treas. J. F. & W. H. Warren Co., 44 Vine St., Worcester, Mass.
By Mr. A. E. ADAMS.

ROBERT C. WEBSTER, Mgr. Barber & Colman, 11 Pemberton Sq., Boston, Mass.
By Mr. WILLIAM P. MCMULLAN.

The PRESIDENT. We will now proceed to ballot on this list, and I will appoint as tellers to distribute, collect and count the ballots, Messrs. GEORGE P. GRANT, Jr., and J. C. SMITH.

The committee proceeded to the discharge of their duties, and subsequently reported as follows:

BOSTON, April 24, 1902.

TO THE MEMBERS OF THE NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION:

The undersigned, the committee appointed to distribute, collect and count ballots for candidates for membership, have attended to that duty

and report that 48 ballots were cast, all unanimous for the entire list of candidates recommended by the Board of Government.

GEORGE P. GRANT, JR.,
J. C. SMITH,
Committee.

The PRESIDENT. Gentlemen, you hear the report of the tellers of election, which shows that of the 48 ballots cast all are unanimous for the list which has been read. I therefore declare the same elected.

ELECTION OF OFFICERS.

The PRESIDENT. We will now listen to the report of the committee on nomination of officers for the ensuing year.

Mr. WALTER E. PARKER, for the nominating committee, submitted the following report:

BOSTON, April 24, 1902.

TO THE MEMBERS OF THE NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION:

The undersigned members of the nominating committee have attended to their duties and respectfully submit the following nominations:

For President, CHARLES H. FISH.

For Vice-Presidents, HERBERT E. WALMSLEY, ALFRED E. ADAMS.

For Directors for three years, WILLIAM D. PENNELL, J. R. MONTGOMERY.

For Director for two years, JAMES R. McCOLL.

Respectfully submitted,
W. E. PARKER, *Chairman,*
M. F. FOSTER,
S. A. KNIGHT,
H. L. PRATT,
EDWARD N. BURKE,
Nominating Committee.

Mr. WALTER E. PARKER. Mr. President, I move that the

secretary be authorized to cast one ballot for the names just read for officers for the ensuing year.

The motion, being seconded, was put to vote and unanimously carried.

The SECRETARY. As the presiding officer is an interested party and acting under the instructions of the unanimous vote of the meeting, I declare this to be my ballot (reading names as reported above). And, therefore, under the conditions of the vote, I declare them elected as stated.

The PRESIDENT. Gentlemen, in reference to this vote just taken, I must say that perhaps I had looked forward with some sense of relief to, not giving up this work, because it is very pleasant, but as duties elsewhere seem to claim a great part of my time, I did not feel as if I could give the time to the Association that the president ought to give to it. However, as the matter has turned in this way, I simply wish to thank you for this additional honor. If I have met with any measure of success during the past year, it has been largely on account of the untiring efforts of the Board of Government and of the Secretary, Mr. WOODBURY; and I am very glad to thus publicly thank them for the assistance that they have given to me. I am very much obliged to you, gentlemen, and I will do the best I can, which is not very much. [Applause.]

The following papers were read:

The Nernst Lamp in Industrial Establishments.
(Illustrated by the Stereopticon.)
MURRAY C. BEEBE, Pittsburg, Pa.

Discussed by Messrs. WILLIAM D. HARTSHORNE, EDWARD ATKINSON, CHARLES H. FISH, THOMAS H. SMITH and W. B. SMITH WHALEY.

Viscose, as Applied to Textiles.
CHARLES N. WAITE, 35th St. and Gray's Ferry Road, Philadelphia, Pa.

Read by the Secretary in the absence of the author.

Japanese Cotton Mills.

TETSUTARO INUMARU, Tokio, Japan.

Read by title.

WELCOME TO ENGLISH VISITORS.

The PRESIDENT. Gentlemen, as President of your Association, I wish to welcome to this meeting this afternoon and to America, the members of the Lancashire Manufacturers' Association who have just come to this country for business and for pleasure, we hope, and I am much pleased to say that we have with us this afternoon Mr. HENRY HIGSON, Chairman of that Association. I should like to introduce to you, if you please, Mr. HENRY HIGSON. [Applause.]

Mr. HENRY HIGSON, of Blackburn, England. Mr. Chairman, I suppose I may be bold enough to call you all brethren or relatives — children — all sorts of names are given to our American friends. And I must say that had I had any remote vision of having to appear before you in this capacity this afternoon, I should have hesitated very seriously before taking my ticket. However, we are here, and we are here for the purpose of greeting you and here for the purpose of receiving from you hearty good wishes, and we are here for the purpose of conveying the same to you.

Now we are all, I take it, brethren in — I won't call it distress; some of us have been pretty fortunate; others have been perhaps as unfortunate. I look around this room this afternoon and I see that care and worry and anxiety have made their impress on many of the members of your Association. I may tell you at once that this body is quite as healthy, as vigorous and as intellectual looking as any company you will find of Lancashire manufacturers. We do claim to work hard, and we understand that you work hard. Some of us have attempted to make a short cut to riches, and we have come, as we say in Lancashire, "a cropper,"— have fallen through; and I must say that many

of the same characteristics possess the gentlemen on this side who are in the cotton trade.

Now it is not at all with a view of coming to pirate any ideas that you may have in the cotton trade, that we have come to America. We are all interested in the production of an article that is calculated to adorn and to comfort the people of the world, and if we can only see eye to eye and be helpful to each other, the probabilities are that the visit that the members of the North and Northeast Lancashire Cotton Spinners' Association are paying you today may be as helpful to you as it will be helpful to us. [Applause.] I sincerely hope that not a single suggestion will be made that we feel that we are losers in the race, that we are likely to be left behind. We are just of that feeling in Lancashire and I am sure you are here — that if there is anybody to be beaten it is our competitors, and we have yet to ascertain who are our competitors. We want to go along parallel lines, and I am quite sure that, having agreed amongst ourselves that good feeling shall be the lines upon which we shall work, it will be very helpful to every one of us.

I am deeply grateful to your President for asking me to say these few words and for asking me to introduce this deputation of members from Lancashire. I am sure that every member of them in whose name I speak just now appreciates it very, very highly. [Applause.]

INSURANCE ENGINEERING.

The PRESIDENT. Gentlemen, Mr. EDWARD ATKINSON needs no introduction. He is desirous of saying a few words to you.

Mr. EDWARD ATKINSON. Gentlemen, you have all received, or will receive, the sketch of a plan for establishing an experiment station in insurance engineering. We have served you all as Spanish flies and porous plasters, keeping you in a constant state of irritation a great many years, until we have exhausted the subject of mill insurance and prevention of loss on the present types of your mills, and our dividends may perhaps justify

the constant nagging and irritation to which you have been subjected for the past 25 years under my leadership. Of late, a great many questions have come to us that we could not answer. With the incoming of steel, of concretes, of new methods of construction, new questions are right upon us. I found that we could not rightly spend the money that we received from premiums, and that somebody must begin at least to comprehend insurance engineering — not so much for your benefit as for the benefit of your customers in all the great cities, who are now finding it impossible to get contracts of insurance enough to sustain their credit. All this is stated in the circular that you have received, or that you will receive. The appeal is just out. I merely want to say to you that the response is exceedingly gratifying. I have already money enough pledged at the rate of one cent per $100 on the amount of mutual insurance that you carry, to give me already as much money as we could possibly spend during the present summer, and we shall immediately organize and be prepared to answer your questions on steel construction, on concretes, on cements, and on any other of the mill problems that are now coming up since the scarcity of timber and the changing conditions may very considerably alter, not so much, perhaps, the construction of the factory itself as of the dyeing and printing and bleaching establishments and auxillary works. I therefore want to assure you, most of whom represent agencies rather than treasurers and principals, that the response from the principals have been exceedingly gratifying, and that we shall be prepared, and that now I am going to be ready if I can to answer any problem that you may present to us on any of these questions, as we have on many questions on which we have standardized so many methods. I thought you would be glad to hear this, and it has been to me an exceedingly gratifying thing, because it justifies what we have done. This is not visionary. I am going on into old age, and you look so young now, most of you, that I feel comparatively a stranger here. I don't know half my own clients. I forget everybody else's name all of the time and my own part of the time. (Laughter.)

After 60 years of regular work and 25 years in your service, this department of insurance engineering will perhaps be my monument. I hope it will be well built, and it depends a good deal on whether you sustain me or not, as you have previously in spite of all my nagging, how much the success will be. [Applause.

THE ASSOCIATION MEDAL.

The PRESIDENT. Gentlemen, I have been asked a number of questions in reference to this Association Medal which was received yesterday by Mr. SIDNEY B. PAINE and myself, and I have been requested to show this medal. I think perhaps there are a number of you here who have never seen an Association medal, and it is well worthy of your inspection. And if you please, I will let this be passed around the hall.

The following papers were postponed to a subsequent meeting:

Bleaching.

ARTHUR C. FREEMAN, 39-41 Cortlandt St., New York, N. Y.

Supervision of Mills.

CHARLES W. DENNETT, North Adams, Mass.

The PRESIDENT. Gentlemen, I wish to speak one moment on the subject of the fund for the Eli Whitney Tablet. Circulars were sent to the members some time ago and most of them were heard from, but the Treasurer reports he is still short some considerable sum of the amount which we ought to have. Mr. Secretary, have you anything to suggest?

The SECRETARY. There have been some contributions made. The subscription is now within $30 or $40 of what we expect the expense will be.

The PRESIDENT. If any of you have been forgotten, you need not feel at all backward in saying so. We should like to

receive a few more contributions, to assure a fund sufficient to do this work as it ought to be done. I simply call your attention to that matter and leave you to your own action.

Is there any further business to come before this meeting? If not, I declare this convention dissolved and trust I shall see you all next fall at the meeting, the place of which is not yet decided upon.

Adjourned.

Attest,

C. J. H. WOODBURY,

Secretary.

TRANSACTIONS.

FIRST SESSION.

WEDNESDAY MORNING, APRIL 23, 1902.

The Association met in Chipman Hall, Boston, at 11 A. M., President FISH in the chair.

The PRESIDENT. We will now proceed to the reading of papers. The first paper on the programme is Methods of Cotton Textile Instruction, by Mr. W. W. CROSBY of the Lowell Textile School. [Applause.]

*METHODS OF TEXTILE INSTRUCTION.

WILLIAM W. CROSBY, Principal Lowell Textile School.

At the present time there is much discussion as to what constitutes an education and what constitutes a training, and again how far education and training may be carried on together. At the outset it is universally admitted that an immature mind is not fitted to assimilate other than elementary facts and that the process of reasoning must be developed, so that later on the mind may think and reason, surely and intelligently. At just what point the presentation of those things which may be turned to definite use later on, should be brought in, must of necessity depend largely with the individual in question. It is admitted that the stronger a mind, the more training and development it has had before committing it to a definite task, the more readily is the task accomplished. It may be, as in the case of an athlete, that too much training makes one grow stale or muscle-bound and he must be put into the active contest not too late. Again we see that a man may study the laws of mechanism and math-

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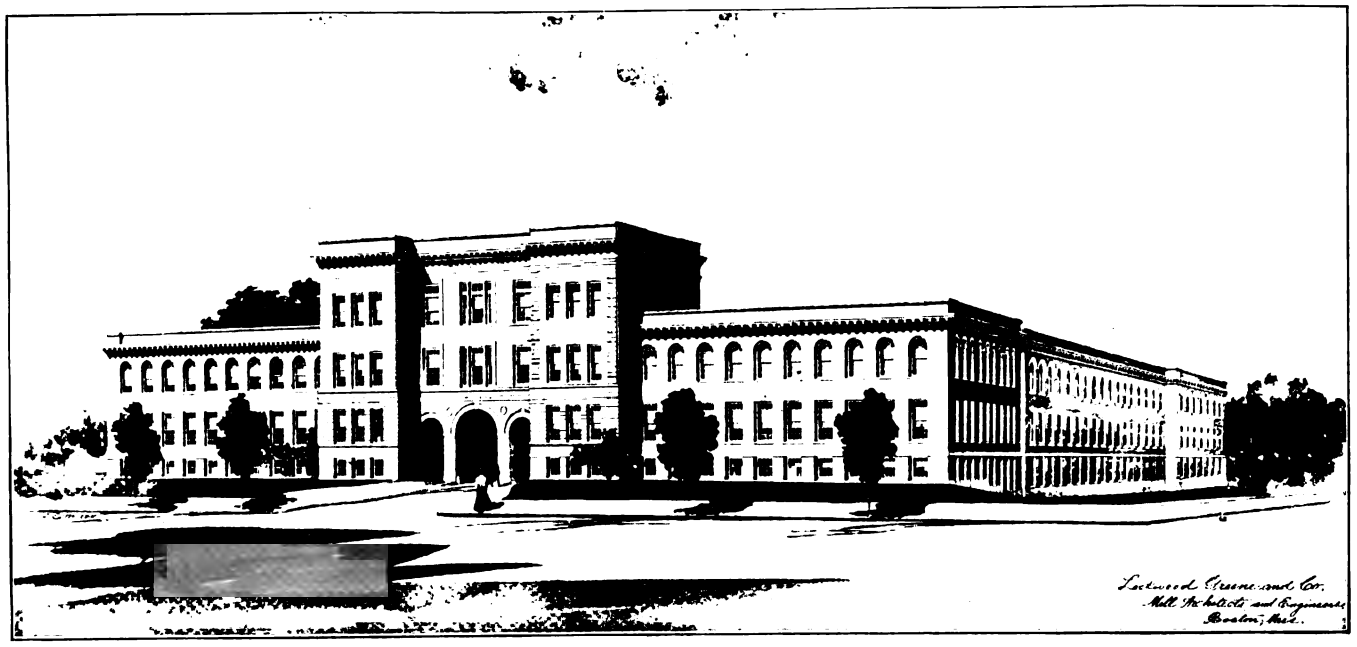
* For further references on this subject see Transactions as follows:

Resolutions on Textile Education, Vol. 6, p. 5; Vol. 64, p. 95.
Report of a Committee, Vol. 8, p. 19.
Technical Education in the Manufacture of Textiles, EDWARD W. FRANCE. Vol. 60, p. 187.
Public Textile Education in Massachusetts, FRANK P. BENNETT. Vol. 60, p. 208.
Textile Education, WILLIAM G. NICHOLS. Vol. 61, p. 189.
The Importance of the Artistic Element in Textile Education, EDWARD W. FRANCE, Vol. 63, p. 113.
Purpose of Textile Education, C. J. H. WOODBURY. Vol. 63, p. 251.
Textile Instruction by Mail, CHRISTOPHER P. BROOKS. Vol. 67, p. 142.

ematics abstractly, until he has at his command the power to solve equations of the highest degree with the greatest facility, and yet not be able to go far toward the designing of the truss which shall bridge the stream or build the trans-Atlantic liner. It is a serious question how to develop the oncoming generation so that tomorrow they may be the clever assistant of you men of today, and later, that they may be ready to take your places.

Our age has been criticised as being utilitarian. Granted that it is, who would dare to attempt to disprove that the useful results of our great engineering operations in producing for us the steamship, the railroad, the telegraph, the telephone, and all other things of a kindred nature, have not added materially to the advance of culture and learning in general? Who can say but that they bring into the span of a man's life today, more than was included in the lives of many generations in by-gone days? Whatever we take up today is done with a definite idea of the result to be accomplished, and the question is ever kept clearly in mind, "Is it worth while"? With the inception of any enterprise we look about to see what others have done in a similar line, that we may take advantage of their experiences, hoping to avoid the pit-falls into which they have stumbled and thereby build more surely for our own success; and so, certain of the members of your Association took up the problem of the scientific training of men to carry forward the great enterprise of converting the raw cotton into the finished goods. It was admitted at the outset, that the apprenticeship system while not lacking in splendid results, might be bettered. New forces were being brought to bear all the time, machinery was being constructed in a more and more complicated form, for the production of finer and higher grade goods and so large an amount of detail which once had been foreign to the subject, was being introduced that higher training than could be acquired in the busy mill and shop became imperative. America had recognized this fact in its great iron and steel industries and in several other large lines, and indeed the development of the methods of the Massachusetts Institute of Technology has aided immensely, as



SOUTHWICK HALL, LOWELL TEXTILE SCHOOL.

we have seen, in the carrying out of all the details of these vast enterprises, even though a most prominent man in the Steel Trust has attempted to discredit such influences.

The question as to education and training suggested in the opening lines of this paper, was given serious consideration, and after due deliberation it was felt that along with the completion of the general training of the young man's mind there should be put the details of that which would eventually be of practical use to him.

In reviewing what had been accomplished in the line of textile education in Europe, it was found that the reputation of a few leading schools towered far above the others. It was seen that many schools were needed and that almost every district which included textile manufacturing was provided with some school which added much to the reputation of the district, but that the inspiration and incentive were drawn largely from outside sources. A personal visit to the large schools revealed the fact that unless the preliminary training and qualifications of those who undertook the work were high, the technical experience in the school, was of little or no avail. Again it was seen that the different subdivisions of the industry were not to be found complete in any one of the schools, although efforts were made to include them; but that one district was noted for its cotton, another for its woolen, another for its worsted, another for dyeing, and so on. This might have done well enough when the actual results wanted were kept clearly and distinctly within these general lines, but we have seen a similar operation tried in our own country in other lines. One of the important reasons why the Massachusetts Institute of Technology is so successful is that it embraces within itself the details of all the engineering branches and that the courses are interdependent. The dividing line between civil and mechanical engineering is not sharply drawn nor again between mechanical and electrical engineering and a man in mechanical engineering must today have some knowledge of chemistry, not perhaps enough to enable him to complete a difficult organic combustion but, for example, that he may be

familiar with the causes of boiler scale, its prevention and cure, or the effect of concrete on steel, a favorite combination at the present time.

With all the general engineering branches at hand, while making mechanical engineering his main point, the student is given the advantage of having access to the lectures and advice of a leading authority in any of the allied branches which may be necessary.

Just so in textile education at the present time, no one branch is entirely divorced or separate from any other. And again, so it is with the textile school, dealing as it does with a wide range of possibilities, with fibres which embrace the greatest peculiarities and yet are used today in all possible combinations; to study aud handle intelligently the physical properties of these fibres, necessitates a most thorough and complete equipment and training.

It is a matter of necessity, that if the highest results are to be obtained, and it is most surely the case that higher results are possible than have been attained in Europe, an entirely comprehensive and thorough course of training must be provided. We well know that the difficulties encountered in spinning fine yarns as compared with the spinning of coarse numbers are many fold greater than the ratio of the counts would suggest. We have today the application of many chemical processes which change the fibre, giving it a more marketable and valuable appearance, and the dyeing and finishing in general require a careful training not merely in the rudiments, but in the very highest forms of chemistry and physics. It is true that we can go to men who make specialities of chemistry and research work in general and have them produce formulae on which to work, but unless they are closely in touch with the practical results needed, with the methods of manipulation and the possibilities of producing goods that may be sold with a reasonable profit, we have not made a success. There must be the men trained to unite these two portions of the work.

The mere filling of a large room with a great assortment of

machinery or apparatus of any kind does not make a school. It is the brain that directs all this and the personality of the man who stands behind it to infuse it and enthuse it with life. Among the European schools were found many points of individual excellence, but this did not seem to strike all the way through, for example, the instruction in weaving at the Glasgow school was worthy of note, designing at Yorkshire College, the manipulation of cotton at Manchester, the weaving at Crefield, and so on, but for a comprehensive scheme and for methods of carrying out the instruction there was nothing to compare directly or indirectly with the methods of the Massachusetts Institute of Technology, although in different industrial lines. To enter this institution and carry on the work successfully, it is necessary that the earliest training shall be properly directed and that the several succeeding steps be systematically taken, bringing the student up to his entrance, well grounded in those elements of general training which are absolutely essential to his future success. The immediate problems are of so much importance and there is such demand for men trained along particular lines that not a great amount of time can possibly be spent with that which does not conduce directly to the point at hand, that is to say, while general training may lead a man to think very intelligently and concentrate his mind upon a definite problem to better advantage, the study of dead languages or of an extensive amount of English literature, or history, must be dispensed with, putting in its place mathematics and natural science, for these are the elements that enter into the real work.

America has been criticised sharply for rushing and hurrying to such an extent that its work is not well done, being slighted at many points. When margins are expressed in fractions of a cent, we well know that the only way to make any profit is in a tremendous amount of business and this can be accomplished only by the application of great pressure, to put a large amount of stock through in the shortest possible time. While this may be all right in a lower and cheaper grade of goods in a manufacturing operation, and may turn out a large amount of fair work,

applied to our systems of education it will not do; here every effort must be expended to have the work of the best grade.

Most of the useful arts of the present time had their origin so far back in the past, that in the transmission of their details, which of necessity was from father to son, where the son watched the father until he could perform the operation as well as his father did, it took the form of what we today call, "learning a trade." If a mason were erecting a wall, his apprentice learned to find the fact of the stone, that it should have a proper bearing, and make a mortar composed of arbitrarilly selected proportions of lime, sand and water. With the buildings of proportions to which he had been accustomed, it was an easy matter to put in a foundation that should be strong enough, but when land became more valuable and the buildings grew higher so that the land covered by the increased thickness of his foundations was worth a large amount of money, how could this man know of or use a skeleton frame of steel sheathed as it were, with a facing of brick and stone, thereby reducing the massiveness of the simple masonry construction and utilizing to the best advantage the costly land; for, indeed, what had a mason to know of steel, or again where would a mason by himself be, even though he had constructed the Cloaca Maxima, the great aqueducts, the Greek and Roman temples, or the cathedrals of the middle ages, when he wanted to bridge a Niagara Falls or an East River? He could build the massive piers and foundations but to span the distance he must have recourse to another trade. The building of a bridge unless it were the simplest form of the single truss was not possible by the mere manipulation of the trade alone. It did not come into existence until the researches of mathematicians and physicists had shown what the proper relations must be between the several parts, therefore the designing of such constructions was from the first left to the trained man, that is to him who had studied the general aspect of the case with its several interdependent relations, and who must furnish the artisan with the sizes of the several parts he should use. It is easy to see therefore how the engineer was

recognized in the matter of bridge building and yet might have been discredited when dealing with older forms of construction which had had certain results in days gone by, although this same engineer later on, in the question of masonry for example, was able to teach the mason who had used his common arch for hundreds of years, how to combine with the well known compressive strength of the masonry, the added advantage of high tensile strength by using steel with it.

The problem of spinning and weaving has been before the world ever since the apple incident in the beautiful garden, for undoubtedly after satisfying his hunger, possibly the apple was called into requisition on that account, man felt next compelled to provide himself with suitable raiment, and we know that he was not long in learning that short fibres might be twisted together so as to form a continuous strand which might be interlaced with others and form a fabric. History is replete with references to the fineness and beauty of texture of the fabrics of olden time. We know that they were wrought in beautiful designs and made attractive by the most harmoniously blended colors, and yet for many ages there was nothing to depend upon to help the hand except some of the crudest of machines. It is not strange, therefore, that these simple operations should be regarded as parts of a handicraft, the details of which were easily transmitted from father to son, and that they should have come up to the present time with the idea that they were parts of a trade.

But while the population of the world was still much smaller than it is today and while our forefathers were satisfied with but a few textile fabrics, we today demand them in profusion and in great variety. Whether the demand has been created by the increased facilities in the application of machinery to their production or not, we cannot say, but surely the increased demand is here and here to stay and we must meet it. It seems to be a fundamental principle with Americans, that whatever is worth doing, is worth doing well, despite the fact that they are, as has been before said, subject to the criticism that they slight things

and do their work imperfectly and hurriedly; but in such cases it is the quantity that is considered and not the quality. When any enterprise, when any industry has promised large results, no pains were too great for us to take, to place it upon the highest possible plane. In the early days of machine construction it was not thought amiss to make the coke at the mouths of existing mines, transporting it to the source of the iron ore, smelt the iron and ship the pig iron to points where it was made into machinery; but today our great steel industries have made it possible, by eliminating all useless transportation, for a finished rail to be turned out where the metal has never been cooled from the moment that the iron oxides were reduced to the metallic state, thereby reducing the cost to such a point that we can sell to the whole world. Scientifically trained men are a necessary part of the general scheme, and it is our intention to train them for the textile interests in the best possible way, that they may think and act with the greatest degree of intelligence.

It has been said that machines alone cannot make a school, yet in order to train men properly we must have a sufficient number of machines and in sufficient variety to bring out the main points. It would not be feasible to have a sample of every machine that has been made or even of all those in common practice, for the room required would multiply to tremendous proportions; but it is possible to select these machines with such care that the fundamental processes may be thoroughly illustrated and studied in such a way that the results may be put into actual use.

Whether in cotton spinning or in any other form of manufacturing, it is necessary to come down to the physical characteristics of the raw product and so adapt the machine that it will handle this properly and develop the product to suit our ends. Although the individual fibre of cotton may be as fine as $\frac{1}{1600}$ of an inch in diameter, yet it is perfectly visible to the unaided eye and in mass is surely a most tangible matter; many of its characteristics and perhaps its most important characteristic, that of being twisted so as to form a continuous strand, has been

learned by trial and error so that, as we all know, wonderfully perfect machines have been developed to do this work for us. It was surely done by hand successfully, even if the production were not great, long before such a thing as a microscope was known. But when the microscope was brought to bear, many points were discovered with relation to these same cotton fibres which had hitherto been unknown and unsuspected. That these fibres only an inch or two long could be twisted into a continuous strand was well known, but why they should hold together in this way was not revealed until shown by the glass. Then the natural convolutions were revealed and it was understood how they could cling together so tenaciously. This soon led to the elimination of any process which should tend to destroy these convolutions, thereby bettering the product.

In these days when novelties are demanded, when new processes are coming to hand all the time, recourse must be had to the microscope, to the balance, to chemical reactions and other methods of precision, not merely to defend against attacks and infringements or to prove proprietory rights, but to further actual manufacture. Although the cotton fibre is so small, it is not impossible that it may be partially cleft by some crude process, as for instance saw ginning, and many instances have been found by the writer by the aid of the microscrope where a distinct nicking of the shaft had taken place; might this not account, if present in sufficient quantities, for uneven or neppy yarn, where it is supposed that all due care had been used in setting the drawing rollers and where no other reason could be ascribed, and how could it be discovered otherwise? Another interesting point even though it may be small and comparatively unimportant is, that owing to the natural set or wavings of the cotton fibre as it comes from the balé, it may not present immediately its true length of staple; it it true from actual experiment that such a fibre may stand a strain of from 5 to 100 m. g. without being straightened out. This does not refer to the natural convolutions but to the wrinklings, if you please, that may be seen with the naked eye. The tensile strength of a single fibre of

cotton has been assumed to equal the strength of wrought iron or steel; this, from recent figures seems to be distinctly erroneous, possibly through the difficulty in measuring an actual cross-section of a cotton fibre, but in any event it is equal to the strength of good cast iron; but if a comparison be made, it is easily seen that the strength of a single strand of yarn is many times less than the strength of an equivalent number of single fibres, as shown by their separate breaking strengths. It is admitted that there is a certain amount of slipping and well we know that the introduction of twist adds to the strength of the yarn, presumably by eliminating a certain portion of the slipping, giving more nearly the aggregate strength of the individual fibres, but with the discrepancy noted, there is the best reason for investigation. There are as well the questions of hygroscopic condition of the cotton and the effect of moisture upon it. We know thoroughly well that the moisture of the air in our spinning departments allows us on the coldest winter's day to dissipate the electricity which accumulates on our machines, breaking down our ends and causing trouble generally. We know further that it is not necessarily a natural condition peculiar to some particular location on the earth's surface, but that it is one actually possible to estimate and to be reproduced by our engineers. There is, however, the problem of investigating the action of the moisture on the fibre, what is does to the strength, elasticity, etc. With cotton we know that there is not the great hygroscopic property that we find in wool or silk. In these two fibres the most elaborate pains are taken to estimate the moisture, in buying or selling, for with the possibilities of taking up 30 or more per cent. of their weight in water and with their great vulue, it means much to the manufacturer, whether he is paying for water or for wool. In cotton, the same conditions are present although to a lesser degree. As we go toward finer numbers, however, more attention must be given to this subject, and methods of precision must be used if our estimates are to be correct. Of all forms of deceit none is worse than where a man misleads himself, and this can be done most easily with

instruments that are looked upon as instruments of precision. A microscope, for instance, is a most simple appearing affair and it seems as if it could be used easily and accurately by anybody who can see clearly and move his fingers delicately and carefully; yet if an inexperienced person should attempt to make a measurement by the aid of a microscope, when he had focussed his object carefully and had adjusted the cross hairs of the micrometer, how would he ever suppose that the thickness of the cover glass or transmitting media with reference to the tube length had anything to do with the accuracy of his measurement? Or in using the fine balance without proper experience, would he suspect that a mass of fibre in a closed room with no drafts of air, would absorb moisture so fast that he could not weigh it accurately?

Again, it is a well known fact that the strength of yarn of the same counts and apparently of the same stock and twist will vary by amounts which are much too large; some of the causes which affect this variation we know, others we do not know. More and more the standards of strength are being used for comparison in yarns and fabrics. The various governments are reducing these things to figures, and the mere handle and feel of a piece of goods is not relied upon as the sole test of its value. Where measurements are possible and figures used, there is the greatest chance to eliminate misunderstandings, and in our endeavoring to establish standards, it is the hope, that thereby we simplify all of our processes. To this end if we could have one system of counting all kinds of yarn throughout the world, we would save much time and labor; whether the metric system prevails in this country or not, it would mean but little bother even if we spun yarn exactly as we do now, to have our reels measure one meter around and then adjust our standard skein so that the number of meters of yarn to the gram would represent its counts. This could be carried through all other fibres equally well and when the designer wished to use yarns of different characters there would be much time saved which is now uselessly expended in computations. If then, the problem

is to make fibre into yarn, and the yarn into cloth, the root of the matter lies in ascertaining the physical characteristics of the ultimate elements; and though much can be determined by the looks and feel of the stock, this alone cannot be trusted. If in addition to this hitherto so called practical part, we add the inspection of the fibre aided by lenses, and the moisture determination aided by instruments of precision, the real story will be most easily made known, and yet it is not intended in any way to have it understood that the refinement of the process should be greater than is necessary. For example, if I were measuring a piece of cloth it would be fruitless for me to measure its length to $\frac{1}{1000}$ of an inch even though my apparatus allowed so fine a measurement if I could not lay the piece of cloth on the table so that it could be measured twice alike owing to its stretch, nor again that I should take a micrometer measurement that I was to reproduce by a simple scale where the finished division was one sixty-fourth of an inch.

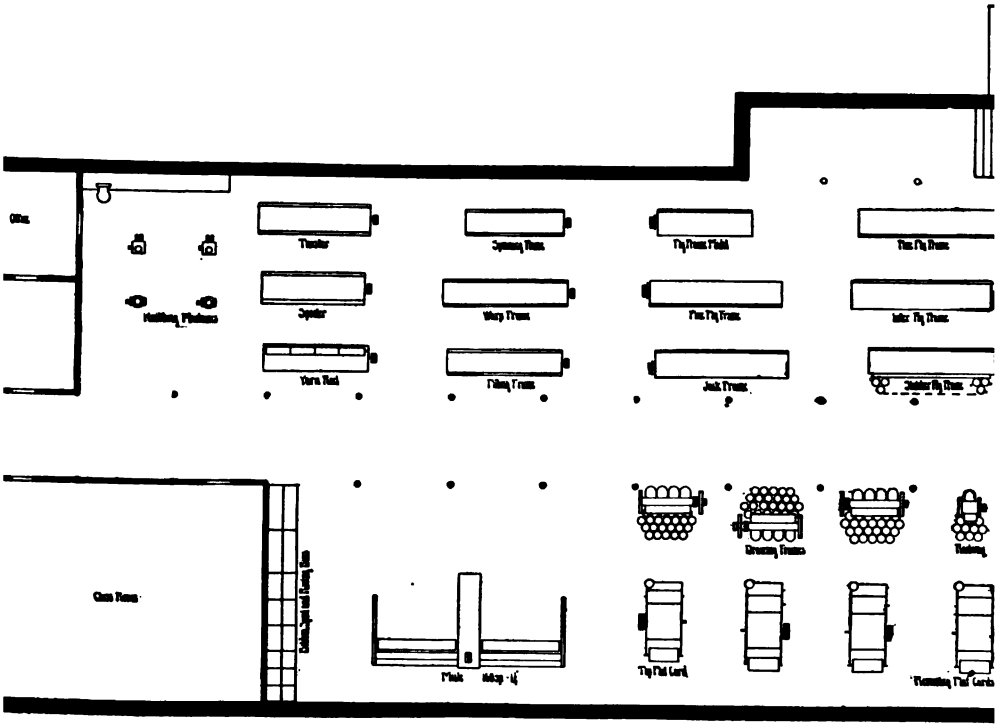
After studying most carefully the physical characteristics of the raw stock and with proper means provided so as to take advantage of the natural properties of the fibre, the construction of the machine which will enable it to run continuously and do good service must be studied. To this end the elements of mechanism, mechanical drawing, and applied mechanics must be brought to bear, not as the main point at issue, but as side lights which should throw into prominence and uphold the main point in hand.

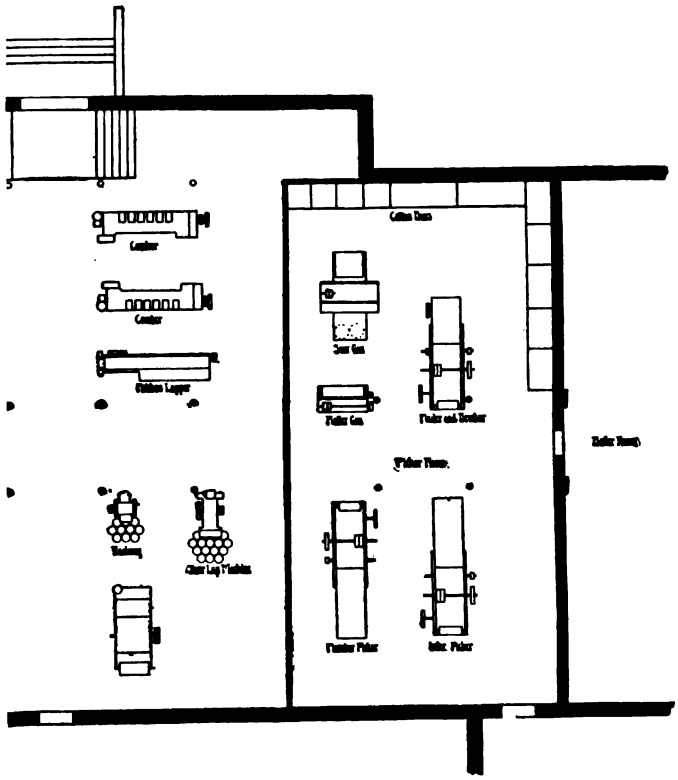
With any school which attempts to reduce to the terms of teaching, processes which have been performed in a practical way, and by practice is meant "result producing," for long years, care should be taken to cause a due observance of whatever has been proved in practice and to take advantage of all the successes accomplished. Whether it conforms to the purely theoretical conditions or not, the best practice as used by our leading mills must be introduced, for the results are obvious and apparent and no better foundation could be taken than these results for the training of the mind to observe and to interpret

discrepancies between the theory and the actual practice. Much is said about the lack of agreement between theory and practice. Whenever I have been able to sift such a case, it has always proved that the theory did not take into account all of the conditions imposed, even though what it did observe was correct, or that the practice was crude or imperfect. We cannot afford today to trust to stumbling upon results; it must be by the direct application of well defined systems of reasoning.

The Lowell Textile School is now in the sixth year of its existence. It was originally proposed as a department of the Massachusetts Institute of Technology but to be located in the vicinity of the mills which would form valuable adjuncts. It aims to establish as high and thorough scientific education in textiles as that Institute aims to in the lines of industry it embraces, and its methods of instruction and administration are modeled after it as far as is practicable. The Trustees in founding it were aware of all these points just noted and it was their aim to provide means for studying these problems for the development of the industry. To this end they assembled a corps of instructors, some of them trained men from our higher institutions of learning to represent the engineering side, others were taken from the mills where they were successfully performing the operations as best practised in producing results, and it can be seen today that no small success has been attained. Those of the instructors who came from the academic side have taken pains to put themselves thoroughly in touch with the result producing side and vice versa those who hitherto have been bent upon actual practice have made themselves familiar with the engineering details involved. By this means a compact whole is attained, well cemented together and this is in accordance with the best practice of the American institutions, whether academic or result producing. A very good start has now been made, but much remains to be entered upon and the field expands every day.

Southwick Hall, 260 x 80 feet, embracing 70,000 square feet of floor space, the first building of the new home of the school, is now practically complete, and will be occupied in the fall. The south wing of this building will be given up entirely to





chemistry, dyeing and finishing. The laboratories will be thoroughly up to date and equipped for instruction in General chemistry, leading towards dyeing and finishing, and all of the special applications such as mercerizing, chlorination, etc. In the basement will be the dyeing and wet finishing. In the north wing will be included general administration, mechanical and electrical engineering, designing and decorative art. The main assembly hall and hand loom division of the school will be in the center portion.

Kitson Hall, the money for which has been donated by Miss CHARLOTTE P. KITSON, Mrs. EMMA K. SCOTT, and the Kitson Machine Company of Lowell is now in process of erection and will be the home of the cotton spinning department. The cotton hall proper is 183 x 60 feet, sufficient space for the installation of representative machines of several types and area for the carrying through of the regular manufacturing processes and for spare machines, which may be studied from a mechanical point of view, to be taken down, leveled up and readjusted. The boiler house which is designed for a maximum of 400 horse power is at the further end of Kitson Hall and will be equipped for the present with 200 horse power of Stirling boilers, and will have as well the most modern and up to date induced draft and smoke consuming apparatus, designed and erected by the Sturtevant Blower Works.

The last building of the group to be erected this summer will face Falmouth Street, parallel to Southwick Hall and will be two stories high 120 x 75 feet providing space for the weaving department, warp preparation and slashing, and the woolen and worsted yarn department. Eventually the fourth side of the square will be closed in by another building.

All this will give the Lowell Textile School the most comprehensive equipment of any such school in the world and it is not without reason, for in the center of a district with so great a diversity of manufacture, and in a general community where textiles are of such importance, the very atmosphere teems with its influence and it is hoped thereby that the greatest service may be rendered to the textile industry.

The PRESIDENT. Gentlemen, you have heard the very interesting paper by Mr. CROSBY. Are there any questions which any one would like to ask him with reference to the subject? I have no doubt he will be very glad to answer them.

Mr. ARTHUR H. LOWE. Mr. President, I would like to inquire of Mr. CROSBY if he could not briefly describe to us the courses at the Lowell Textile School and the length of time required to follow them.

Mr. W. W. CROSBY. I shall be very glad to do so. The work is now divided into five regular courses. When these are analyzed there are really three general departments, cotton, wool and dyeing. Course 1, cotton manufacturing, is intended to include the operation of all spinning machinery, the conversion of the raw stock into the yarn, and then carrying the yarn through the spooling, warping and slashing, and then on to the loom to produce the cloth. In the first term a general course is given, for a great many young men come to the school not knowing what course they want to take. A great many young men are looking about for some engineering profession — and this really amounts to an engineering education — while they do not know precisely what branch they wish to follow; and for this first term they are given the elements of textile designing, including the picking out of fibres and yarns of all kinds, cotton, woolen and worsted. They have to learn the present complicated English system, the system which we still find it necessary to follow, of the various relations of counts — with 840 yards, 560 yards and 300 and 1,600 for constants — and I am sorry to say that a large proportion of time is taken in the cloth analysis class, teaching them this system. There is also a class in mechanical drawing. At the end of the first year they decide whether they will enter the cotton manufacturing, the wool manufacturing or dyeing; and then there is a course in designing and weaving, specializing more fully on designing. Textile designing is carried through as an integral part of all

the courses except the dyeing, where it stops with the first year. Dyeing is carried through all the courses with everybody for two years; those who elect it as a speciality take it the entire course. Those are the main points that occur to me; if I have not covered your exact question I should be glad to explain further.

Mr. ARTHUR H. LOWE. I wanted to know if you had courses for students, for instance, that would take one year or two years or three years, and whether you had courses which would give a student subjects that they would select and pursue for a brief period.

Mr. W. W. CROSBY. The tabular view of the school is so arranged that almost any special arrangement can be made with it, and a man can take cotton spinning or woolen spinning or worsted spinning, or a portion of designing or of cloth analysis or weaving or dyeing — anything that is taught there as a part of the three-year regular diploma course, if he is fitted to take it. But a great many men come with the idea that they will take weaving without understanding designing, expecting that they can learn it all in the weave room. My weaver can teach them all that, but it is better for them to take it in the regular order, designing first. It is very much as if a student should say, "I want to study algebra, but I don't care for arithmetic," and so proceeding with the study of algebra without knowing anything about arithmetic. If he has had the preliminary training he can take any course in the school. It is our intention that a man shall not thresh over old straw, but shall be put into the school as far advanced as his qualifications permit and is allowed to take an examination to enter with advanced standing in any department. The rule is that a young man must be a resident student for one year to take our diploma; if he should come with two years' training, and could pass our examinations, he would be allowed to enter as a third year student or in any of the advanced courses. Whether

a man should be allowed to take mule spinning without knowing anything about carding, drawing or combing is a mooted question. I am not prepared to advocate either side at the present time. My first impulse would be to say that he must follow the processes through systematically. But at the same time, an individual process of that sort stands very much by itself in the mill and is recognized as a distinct trade. I should say it would be very much better for him to follow the course systematically; but so far as taking cotton spinning by itself, he can do so.

The PRESIDENT. If there are no other questions we will proceed with the reading of the next paper on the programme, Brick Factory Chimneys; Some Features of their Construction, by WILLIAM WALLACE CHRISTIE, M. E., of Paterson, N. J.

*BRICK FACTORY CHIMNEYS: SOME FEATURES OF THEIR CONSTRUCTION.

WILLIAM WALLACE CHRISTIE, Paterson, N. J.
Member Am. Soc. Mech. Engineers.

This article will have for its object the consideration of the brick materials used in the construction of brick chimneys and to some extent their disposition in the complete structure.

I like to think that there may be just as valuable work done in the designing of a brick chimney as a steel chimney, or that of any other steel structure.

To be sure the material is liable to be of a non-uniform nature, likewise for steel work we make our calculations by formula the proof of which is not at all satisfactory and cannot even be proven.

There are some engineers who have said to me that chimneys will go out of date soon anyway and if they do not it is easy to throw up four walls or a shaft and get the walls thick enough; but the question is how do they know that "thick enough" gives what would be considered a good or economical structure.

In the United States there is no universally adopted rule for the calculation of the stability of a brick chimney, which takes into consideration the various strengths and kinds of masonry giving them a definite value.

The principal method in design being to have the zero pressure line at such a distance from the axis that the wind

* For further references on this subject see Transactions as follows:
Size of Chimneys, Vol. 29, p. 64.
The Height and Area Required for Chimney Draft, H. G. BRINCKERHOFF, Vol. 68, p. 295.

moment at any section divided by the weight in pounds above that section is equal to or less than one-sixth of the outside diameter of that section.

This method contains only the weight per square foot of masonry and wind pressure per square foot to be predetermined.

The former frequently is given a value of, say, 120 pounds per cubic foot and the later 50 pounds per square foot, which with a factor equal to 0.50 to give the equivalent value of the pressure on a diametral vertical cutting plane of a chimney of circular cross section gives us 25 pounds per square foot.

The strains produced in a shaft by the continually changing direction and pressure of the wind, the variations of the high temperature within the flue compared with the temperature of the outer surface, and the influence of climate on the shaft, all make a chimney shaft a complex structure as far as internal strains are concerned.

All of these tabulated values* of wind pressure are used on the Continent, the last one being used only in excessively dangerous or exposed locations.

Kilogrammes per square meter. A	Pounds per square foot. B	For circular section. B x 0.66
125	25	16.66
150	30	19.8
200	40	26.6
250	50	33.5

The latest Austrian regulations suggest this value for A, in kilogrammes per square meter; or 110 + 0.6 H.

Where H = height of shaft in meters.

For a 100 meter high shaft A = 110 + 60 = 170 kilogrammes per square meter or 34 pounds per square foot = 22.5 pounds per square foot for a chimney of circular cross section using the cross section coefficient = 0.66, in place of 0.5 as used in the United States.

* Stability of Chimneys by O. Jacker, Chief Engineer to H. R. Heinicke.

For a 30 meter shaft A = 110 + 0.6 x 30 = 110 + 18 = 128, or about 17 pounds per square foot for circular section.

This is a wind pressure much below what 50 x 0.50, or 25, a value which has obtained here, would give.

It may be said that the Continental practice in using the coefficient x = 0.66 for obtaining the equivalent up on a round shaft is used in connection with the previous table and the formula that follow it, and the utmost care should be exercised by the person using the factor or the chimney may contain much more material than is necessary.

On the continent a much used unit weight of brick is 1600 kilogrammes per cubic meter or 99.84 pounds per cubic foot with an adhesive strength used in formula equal to 9 kilogrammes per square centimeter for the shaft and for the foundation filled about with earth 2 kilogrammes per square centimeter.

In order that an intelligent estimate might be made of the value of the material used in the United States, I have searched all of the Reports of Tests made by the United States Government at the Watertown Arsenal, Testing Department, and the results are left to the reader.

The ultimate strength of single bricks in compression, from tests of bricks used in Washington, D. C.,* was for:

	Ultimate strength in lbs. per sq. inch.
Red brick,	6,030, 6,050, 6,700, 8,530, 9,540
Pressed brick,	5,960, 6,740, 9,190
Arch brick,	6,800, 7,600, 10,290
Com. Eastern brick 1. crack noticed at about,	5,800, 12,995
†Old Bay State brick 2. crack noticed at about,	7,000, 10,390
Face bricks, 2.1 x 3.7 x 7.75 crack noticed at 5,500 (lowest of a set),	11,056
‡3 Buff bricks tested flat,	7,594, 8,378, 8,426

* 1883 Tests.

† 1, 2.1 x 3.5 x 8.1 inches.
2, 2.05 x 3.6 x 7.8 "

‡ 1897 Tests.

	Ultimate strength in lbs. per sq. inch.
2 Buff bricks tested on edge,	5,829, 5,972
6 White enameled,	4,531 to 4,774
9 Tests San Francisco, terra cotta,	2,669 to 3,165
9 Tests San Francisco, brown brick, 2.5 x 4.1 x 8.33 inches,	5,034 to 6,868
17 Tests Akron Hydr. press brick 2.33 x 4 x 8 inches	10,050 to 25,220

COMMON BRICK.*	Ultimate strength lbs. sq. in.	Mod of Elasticity.
3.35 x 2.18 x 7.60 medium hard bnd., dark red,	14,160	3,750,000
3.40 x 2.28 x 7. 80 " " " light red color,	8,970	2,360,000
3.36 x 2.26 x 7.70 light red color,	7,650	2,200,000
3.46 x 2.27 x 7.90 " " "	7,180	1,700,000
3.37 x 2.27 x 7.68 " " "	7,880	2,700,000
3.33 x 2.24 x medium " "	10,480	2,700,000
3.28 x 2.20 x 7.58 " " "	8,800	3,750,000
3.31 x 2.20 x 7.55 " " "	12,290	3,756,000
3.23 x 2.20 x 7.50 dark " "	13,120	3,750,000
3.18 x 2.18 x 7.48 " " "	13,260	5,000,000
2.20 x 2.18 x 7.58 " " "	12,400	4,600,000
FACE BRICK.*		
3.52 x 2.16 x 7.70 outs of dark red, int. lighter,	8,130	4,070,000
3.50 x 2.14 x 7.70 " " " " " "	7,970	3,080,000
3.60 x 2.16 x 7.78 " " " " " "	6,970	3,150,000
3.58 x 2.21 x 7.68 " " " " " "	7,140	3,750,000
3.58 x 2.10 x 7.70 " " " " " "	5,700	3,300,000
3 62 x 2.16 x 7.82 " " " " " "	6,000	2,500,000

EASTERN FACE BRICK. HARD BURNED RED.

		Ultimate Strength.†	
Placed flatwise,	lbs. sq. in.	9,290 to 13,492	lbs. one brick.
" edgewise,	"	6,714 to 12,297	" "
" endwise,	"	5,837 to 8,032	" "
" flatwise,	"	9,100 to 15,837	" "
" "	"	‡3,733 to §6,812	" more than one brick.

* 1885 Tests.
† 1894 "
‡ 5 "
§ 2 "

		Utlimate strength lbs. sq. in. Standard.	Paving.
Hydraulic press brick, St. Louis,		5,266 to 17,558	lbs.
" " " "		4,794	" brown.
Chicago " "	Chicago,	3,120 to 5,968	" red.
Omaha " "	Omaha,	12,907 to 13,511	" "
Northern " "	Wisconsin Yard,	7,599 to 7,575	" dark red.
Findlay, Ohio " "	Ohio,	9,686 to 12,372	" med. hard burned.
Eastern " " "	Winslow, N. J.	12,123 to 16,252	" buff.
Phil. & Boston Face Brick Co.		2,978 to 12,195	" cream red.
Mather Brick Co, Mankato, Wis.,		11,043	

Absorption of water by volume was from 11.6 to 32 9 per cent. in above samples tested in the year 1894.

Comparative tests at Berlin, give for radial bricks, perforated and unperforated.

	Perforated.	Unperforated.
Compressive strength, lbs. per sq. inch,	5,035	4,978
Adhesive strength of joint, cement mortar, Bricks made of same material,	61½	21¾

Surface area of perforated considered same as for unperforated bricks.

WEIGHT OF RADIAL BRICKS.

Of two radial bricks, which came to me as samples, which I presume were made in the United States, one weighed 15 pounds, 8½ ounces, or equivalent to 105 pounds per cubic foot of wall, no mortar considered.

The other weighed 14 pounds, 3 ounces, or equivalent to 96 pounds per cubic foot of wall, no mortar considered.

The bricks were four inches thick, 10¾ inches long on radial sides, and 6½ inches on the outer circle, and had 15 perforations ¾ x 1 inch extending through them.

I believe it is the practice of the radial brick chimney designers to consider the weight of the wall made of these bricks as 109-110 pounds per cubic foot.

The weight of radial bricks abroad has reached 2,000 kilogrammes per cubic meter or 124.8 pounds per cubic foot.

The effect of using either Rosendale or Portland cement with lime mortar, or alone, is clearly set forth by these tests* of red brick work.

When one part Rosendale or one part Portland cement is added to two parts lime, its effect is comparatively more serious with the Portland than the Rosendale cement, either weakening the mortar to such an extent that there is little difference in the resulting mortar, when either kind of cement is used.

AVERAGE OF SETS.	Ult. strength lbs. sq. in.	Weight of Mortar cu. ft. lbs.
1 L, 3 S,	124	109.08
1 P, 2 S,	546	116.89
1 R, 2 S,	162	108.62
Clear Portland,	3,482	129.93
" Rosendale,	554	96.77
1 P, 2 Lime Mortar (1 L, 3 S),	192	107.42
1 R, 2 Lime Mortar (1 L, 3 S),	193	105.20
Plaster of Paris,	1,931	74.37

Six-inch cubes used for tests.

SYMBOLS.—L = Lime, S = Sand, P = Portland cement, R = Rosendale cement.

From tests* made on 12 x 12 x 72-inch brick piers we may judge the quality of brickwork with reference to the kind of mortar employed.

	COMPOSITION OF MORTAR.	Efficiency of Piers, per cent.	Lbs. per sq. inch.
Bay State Bricks.	1 Lime, 3 sand,	9.9	1,133
	1 Lime, 3 sand,	10.6	1,210
	2 Lime mortar (1 lime, 3 sand) 1 Rosendale cement,	14.4	1,646
	1 Rosendale cement, 2 sand,	17.3	1,972
	2 Lime mortar (1 lime, 3 sand) 1 Portland cement,	12.4	1,411
	1 Portland cement, 2 sand,	15.7	1,792
	Clear Portland cement.	20.8	2,375
Common Brick.	1 Lime, 3 sand 5 tests.	6.1 to 13.3	1,118 to 2,440
	1 Port. cement, 2 sand, 3 tests,	10.3, 10.9, 14.8	1,887, 2,003, 2,720

$$\text{Efficiency of pier} = \left\{ \frac{\text{Unit strength of pier.}}{\text{Unit strength of single brick.}} \right.$$

* 1884 Tests.

From the above it is a question whether a factor of safety of 10 for the compressive strength of the brick in a wall is sufficient, as one of the above results — first test was lower than that; the factor should be made to suit both the mortar and the quality of brick used.

Tests on piers *22½ inches high, 22 months old, built up of North River brick 8 inches x 3½ x 2¼ inches, in a mortar composed of one part Newark Company's Rosendale cement and two parts sand give:

WEIGHT PER CUBIC FOOT.	Ultimate Strength.	
	Per square inch. Lbs.	Per square foot. Tons.
113	2,021	145.5
113	1,805	130
113	1,780	125.5
111	1,821	131
111	1,736	125
112	1,944	140

PIER TESTS. (1884)

"In examining the results of the cement and mortar tests, superior strength is found in the use of Portland cement; likewise the piers laid in Portland cement give the highest resistance, while piers of the same kind of bricks but laid in weaker mortar showed lower results, from which it appears that the quality of mortar employed has a very important function in the strength of brick work," and from these tests it is likewise learned that the

"Yielding of piers is confined largely to mortar in the joints," and that

"Laying the bricks on edge appears to have a tendency to increase the strength of the pier."

* 1884 Tests.

	Ultimate Compressive Strength. Lbs. per sq. inch.	
	Lime Mortar.	Portland 1 part, Sand 2 parts.
Common brick,	2,150 to 1,118	2,003
Face brick,	1,940 to 1,511	2,253
Bay state brick,	1,370 to 924	
Size of Piers,	12" x 12" x 24" h.	12" x 12" x 10" h.

Increasing the height of piers or enlarging their cross-section effects a decided reduction in their resistance to compression; piers with broad stones are also found by actual test to have a strength which is intermediate between the strength of a pier of the total height tested and those of a height equal to the distance apart of the bond stones.

Tests* of brick piers laid in a mortar of one part Rosendale cement to two parts sand gave:

	Wt. per cubic foot, lbs.	Brick.	Ultimate strength. lbs. per sq. inch.	Efficiency. per cent.
Aver. 18 tests,	122.9	Common	1,770	11.7
Aver. 14 tests,	129.0	Face	1,900	14.5
			Failed at lbs.	Lbs. per sq. in.
†A 16-inch square pier in lime mortar,			335,900	1,337
†" " " " " neat Portland cement mortar, or at 2⅓ times the load,			791,200	3,209

A terra cotta, light color, pier showed an ultimate compressive strength of 3,424 pounds per square inch, but a crack enlarged when one-thirteenth of that load had been reached.

In an eight-part hollow terra cotta column, 48.6 inches high, the ultimate compressive strength of the same material was 881 pounds per square inch.

Tests made on fire bricks in 1895 gave their compressive strength from 2,392 to 4,418 pounds per square inch, and in the

* 1886 Tests.

† 1893 Tests.

case of an Arkansas press brick it reached the high point of 21,000 pounds per square inch.

In the 1897 report the coefficient of expansion of red bricks is given as 0.000003 by heat, and by freezing it is about the same, while the permanent set after freezing is given as 0.002 to 0.0002 inches in 6 inches.

TITLE TESTS. 1894.	Size of Bricks. Inches.	Dry Weight. Lbs. Oz.	Absorption per cent. Water by Volume.	Wt. Strength lbs. per sq. in. Compression.	Color.
Fire brick XX. Utica, Ill.	2.66 x 4.39 x 9.20	7—5¾	24.5	4,244	Cream
" " " " "	2.65 x 4.32 x 9.00	7—7	18.6	3,966	Buff
Vitrified brick,	2.25 x 3.58 x 7.67	5—6	0.70	12,280	Dark red
" "	2.24 x 3.62 x 7.73	5—7¼	0.00	8,252	" "
Japanese white fire brick,	2.48 x 4.38 x 9.21	7—0½	18.6	5,529	White
" " " "	2.50 x 4.45 x 9.31	7—5¾	18.2	4,782	"
Sweden,	1.93 x 4.20 x 8.33	5—4¾	5.1	22,435	Drab
"	1.93 x 4.16 x 8.33	5—3¼	3.9	22,955*	Brown
" fire brick,	2.47 x 4.77 x 7.43	5—13¾	16.3	7,017	
" "	2.43 x 4.86 x 7.47	5—14¾	16.1	6,501	

The above table tends to show in a general way that the greater the power to absorb water, the weaker the brick as to compressive strength, and the poorer it is as a material to furnish an air-tight wall about the smoke flue of any chimney, whether storehouse or factory chimney.

Mr. GEORGE H. STODDARD in "Cold Storage, Nov., 1901," gives the result of many experiments on brick treated with various water-proofing.

A portion of brick weighing 630.3 grammes bare, 639.10 grammes when treated with three coats of Bay State air and water-proofing gained 0.30 grammes after being in water 24 hours; 1.10 grammes after 72 hours, and 1.50 grammes after 120 hours.

A portion weighing 556.71 grammes bare; 577.11 grammes after two coats of a common mineral paint ground in oil, gained 1.39 grammes after being in water 24 hours; 2.16 grammes after 72 hours; 2.49 grammes after 96 hours; 2.89 grammes after 120 hours.

* Maximum not reached.

Bare brick weighing 489.04 grammes, gained after

24 hours	72 hours	120 hours
21. 26 grammes	39.69 grammes	42.43 grammes

The first gave	0.24%	increase of weight	after	120	hours	in	water.	
" second gave	0.52%	"	"	"	"	"	"	"
" last gave	8.68%	"	"	"	"	"	"	"

Soap and alum and Portland cement and hot paraffine were all unsuccessful.

All that is needed to give a non-absorptive surface to a chimney is to have the exposed outer faces of the bricks used enameled; we may either have the old standbys, red brick, so treated, or use for example the radial brick as now made for chimney building.

In order that I may call to your attention the difference in red bricks I have photographed a soft red brick, one of the poorest obtainable, and a selected North River Haverstraw red brick, both common bricks. See figures 1 and 2.

A pile of radial bricks, in front of which four are set showing the perforations as shown in figure 3.

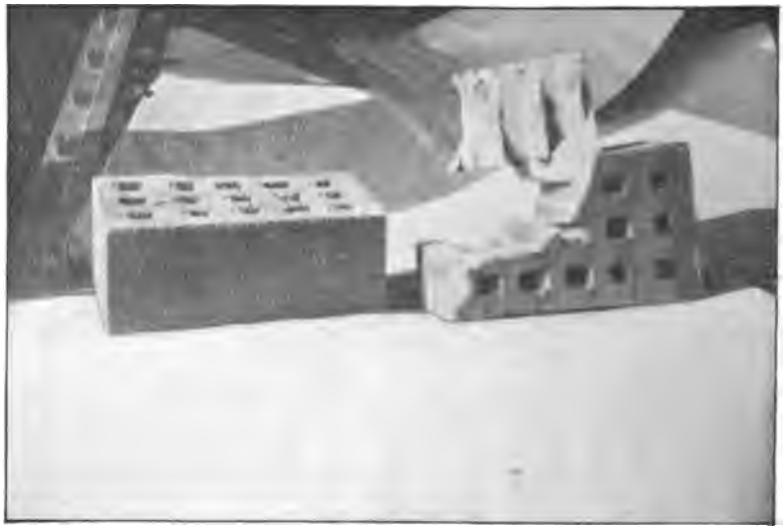
A general idea of the difference in the joints per unit of area of exposed wall and the work in progress is clearly shown on figures 4 and 5, taken just as the radial brick work was starting from the brick base or "sockel" of a large chimney.

Making use of 110 pounds per cubic foot for radial brick and 115 to 125 pounds per cubic foot for common red brick, I have calculated the position of the line of zero pressure for about 100 feet down from the top of three chimneys which have been built for some time, using in each case a wind pressure noted thereon per square foot of diametral area, all of the shafts being circular, and the same inside diameter at the top; see figure 6.

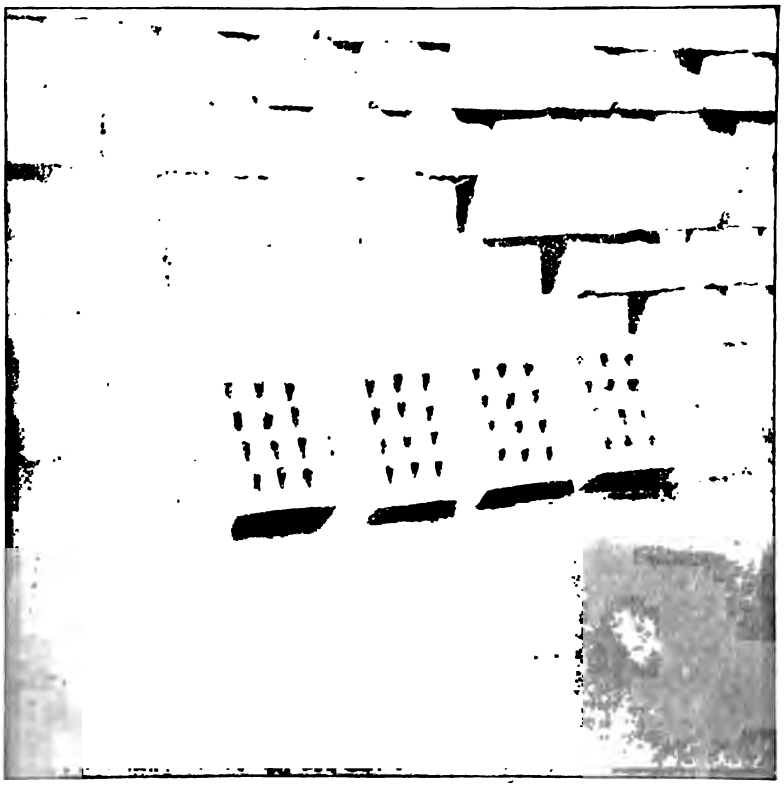
The dotted line is the boundary of the "middle third," and if the line of zero pressure passed through it under the above conditions the edge pressure on the lee-side would be double the unit pressure under wind pressure loads; as the calculated

FIGURE 1.—Red Brick.

FIGURE 2.—Selected Red Brick.



A Broken Radial Brick.



A Pile of Radial Bricks.

FIGURE 3.

FIGURE 4.

FIGURE 5.

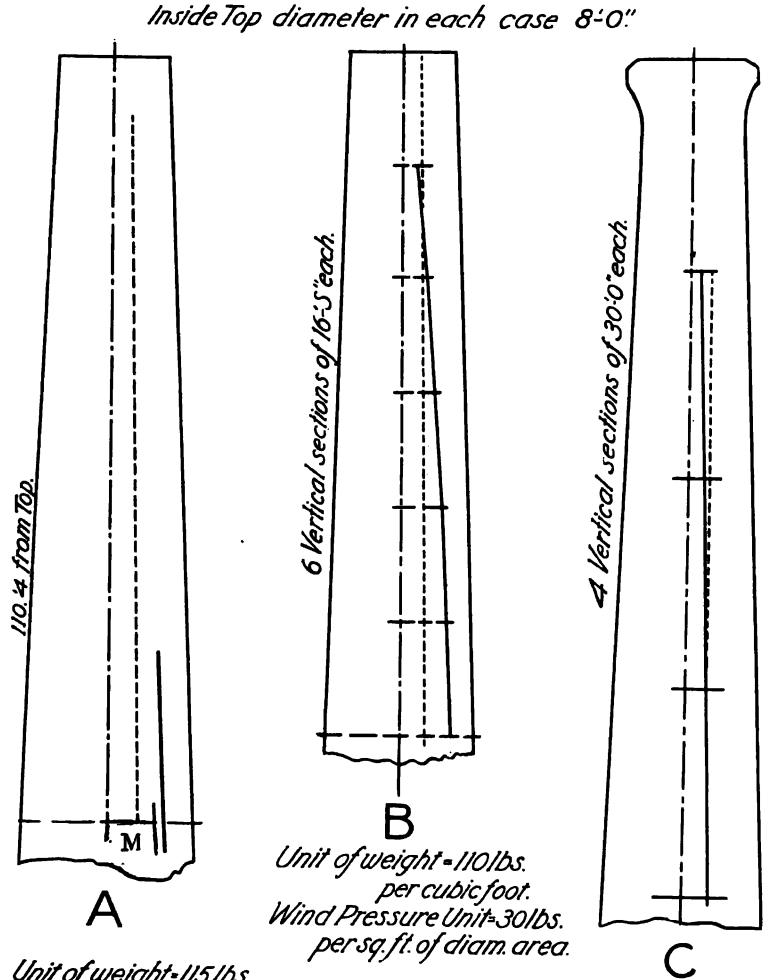

Inside Top diameter in each case 8'-0"
110.4 from Top.
M
A
6 Vertical sections of 16'-5" each.
B
Unit of weight = 110 lbs. per cubic foot.
Wind Pressure Unit = 30 lbs. per sq. ft. of diam. area.
4 Vertical sections of 30'-0" each.
C
Unit of weight = 125 lbs
Wind Pressure Unit = 25 lbs.
Unit of weight = 115 lbs.
Wind pressure Unit = 30 lbs.
if 25 lbs is used Zero line moves back to M. The above chimney has collapsed under excessive wind pressure.

FIG. 6.

STABILITY DIAGRAMS.

zero line for each chimney — full line — moves to the right of the line of the middle third the unit pressure on the lee-side edge increases very rapidly until when the zero line reaches the right or outer edge the chimney would just be ready to tip over and tensile strains would then appear in the windward side which is allowed abroad, as for example in Chemnitz, where one kilogramme per square centimeter tension is allowed in chimneys up to 35 meters high, and must be zero for greater heights, with a wind pressure equal to 125 kilogrammes per square meter, and a cross section coefficient of $x = \frac{2}{3}$ for circular sections.

Austria allows a maximum compression under static load of eight kilogrammes per square centimeter at a two fold security when wind pressure is 150 kilogrammes per square meter and coefficient of $x = \frac{2}{3}$ for circular sections.

Prussia now has a new set of regulations under consideration which refer only to chimneys up to 75 meters high and 3 meters clear diameter, taking wind pressure 150 kilogrammes per square meter and the circle cross section coefficient x equal to 0.67 and the brick laid up in a mortar of 1 part cement to 8-10 parts lime.

The strength of bricks used for chimneys abroad as a rule increases in a greater ratio than their weight, so that the stronger the brick the lighter the walls may be made, for under certain conditions of strength of materials and good workmanship we may safely allow the line of zero pressure to pass without the middle third, but brittleness in the body, and particularly in the face of the brick, is not to be desired, for it is in the very outer face of the bricks that I might say "malleableness" is the most needed.

It is customary, however, to consider the strength as increasing in proportion to the weight. From what little has been brought to your notice it may be gleaned that by carefully weighing the various items that should be considered in the design of a chimney, very much more economical structures may be planned, and be at the same time sufficiently strong to stand up under all conditions of wind and weather.*

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* For illustration of a large number of chimneys see the book "Chimney Design and Theory," by the writer of this article.

While much of this paper is taken up with going over ground familiar to many, yet to some much of it is new, and it is hoped that it may result in bringing out the experiences of others and reports of tests which have been made by others with bricks used in chimney shafts; failures of shafts; or any other notes which will add materially to a present meagre amount of published information in regard to a useful engineering structure.

Mr. SANFORD E. LORING. Mr. President and gentlemen, I came in entirely unconscious of the character of this paper, but was attracted when I found it was a subject for discussion here, and have brought with me some photographic illustrations of some practical results that were secured by the application of the skeleton principle of construction to chimney construction. In the skyscraping buildings that have been built during the last 18 years in different parts of the country, you have become more or less acquainted with what is known as the skeleton principal of construction. I found myself about eight years ago invited by the Stearns Company of Syracuse to erect a large chimney on rather treacherous ground. For the purpose of eliminating as far as possible dead weight in the chimney and relieving the foundation of the necessity of carrying any extra load, I decided to make an application of this principle of chimney construction; and now, after it has faithfully served its purpose for eight or nine years, I feel quite warranted in exploiting some of its good points. And so I take the liberty of showing you a rather rough solartype of this chimney, which is 8 feet in internal diameter and 150 feet high. (See figure 1.) It stands on the edge of a creek where we found a very bad bottom. I started it by making a bed of concrete, in which we placed a grill of old steel rails and upon which were laid very light concrete foundation walls extending to the surface of the

ground, where they were finished with a concrete water table. Into this fonudation I had inserted four lines of three-inch steam pipe, which were anchored at the base and locked into this concrete foundation. These pipes were from time to time increased in height, as the chimney was built up, by simply screwing on additional sections and tying them with very light horizontal pipe connections which were slipped over these vertical ties. The wall of the chimney is constructed, as you see, with an interior lining of what is known as nine-inch porous tile and an exterior facing of four inches of pressed brick, so that so far as volume of solid material is concerned, this chimney has only the equivalent of about seven inches in thickness of solid masonry wall from base to crown.

I confess that I was not without some doubt as to the probable stability of the structure; but it was a case of necessity rather than choice, and so under the conditions I decided to take some chances.

It happened that in the fall of 1896 there swept up the valley in which Syracuse is located the worst tornado that had struck that region in a hundred years. It unroofed many buildings; it tore up the largest trees. In one case I remember it blew in the walls of two stories of heavy brick masonry which was being used in erecting a slow-burning factory construction. The morning after the storm, in which I had been pretty well shaken in my own house, I went down to investigate that chimney the first thing. I also had sent for an engineer to meet me there with his transit and other instruments. With their help we investigated the chimney from base to crown and found no indication whatever of the slightest crack in any of the joints. A few weeks ago, before knowing anything of this topic, I sent the same engineer to investigate again and he reported that the structure had not sustained any injury.

About 600 feet from this chimney we had built a tower 32 feet square and 110 feet high, which was used for painting wire cloth. That tower was of what is known as a monolithic built up skeleton wood frame construction. The law, however, com-

FIGURE 1.

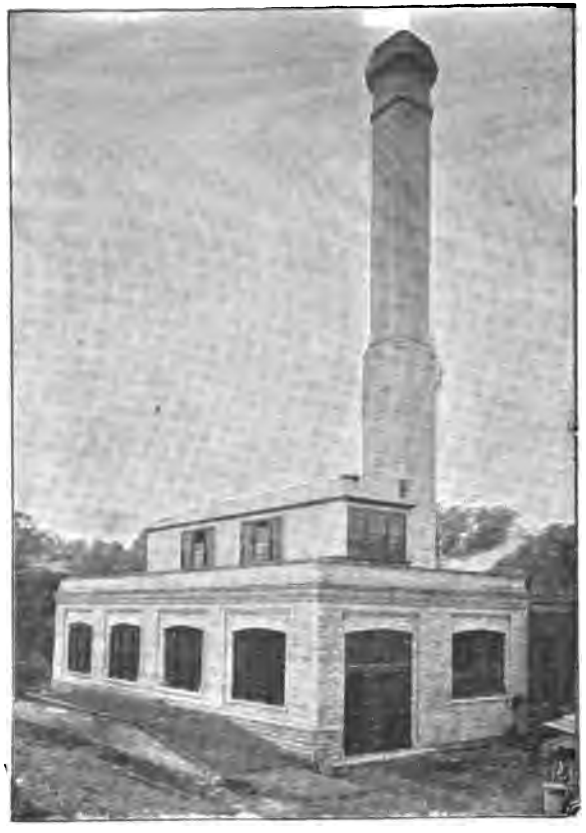

FIGURE 2.

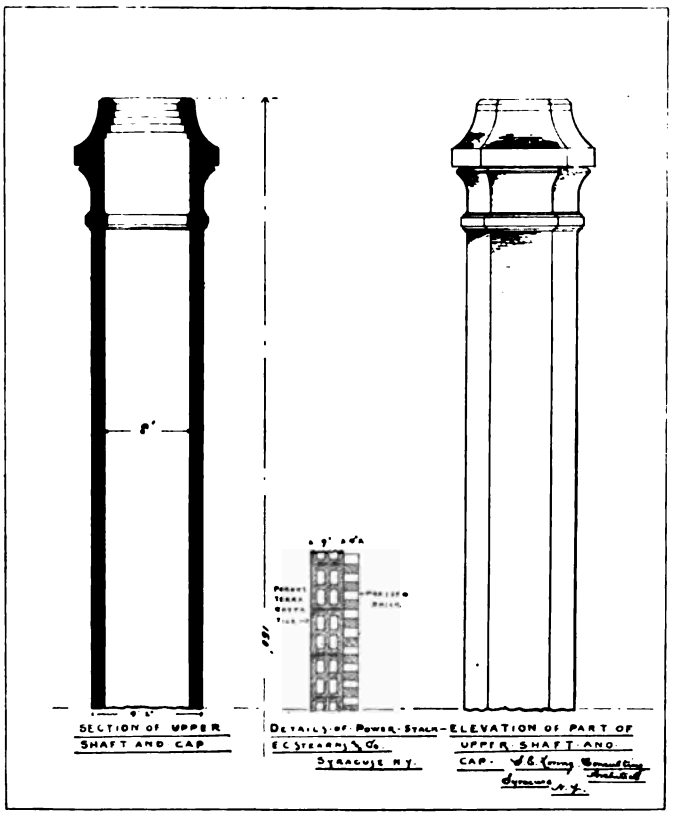

FIGURE 3.

pelled us to build on the outside of it and around it a very large mass, some 500 tons, of brickwork. It was a veneered construction, although not in the ordinary acceptation of the term, because the walls instead of being four inches were two feet thick or more at the base, graduating from that to 13 inches at the top. When I went down to investigate this property the morning after the storm I found the tower in the condition indicated by this photograph. The masons had neglected to anchor one of the corner buttresses to the wooden frame, and

although the wind had taken 60 odd feet of it and thrown it rather recklessly into the next dooryard, it had not broken a light of glass on that side of the tower. And so I bring this photograph to you as a reliable and unquestionable illustration of the power of the wind that this chimney withstood, and incidentally to illustrate the relative strength of what is known as skeleton built-up timber construction when compared with that of heavy walls of masonry, in which we generally have great confidence, as an element of stability in construction. When this engineer investigated the pile of bricks we discovered that there was just one anchor in 66 feet where there should have been five. The chances are that all the other piers which were left intact were properly anchored to this wooden building, and may thank the wooden building for holding them up during this terrific wind storm.

I had intended to bring with me, and I have in my bag at the hotel, a small fragment of this porous material. Before adopting it for use in this chimney we subjected the material to a comparative heat test in order to learn its relative non-conducting value as compared with ordinary brickwork. We found that the non-conducting value of this nine-inch hollow tile was equivalent to that of 24 inches of solid brickwork. Since one of the uses that it was intended to serve, was to prevent the heat of the gases from escaping through the wall of the chimney, I credit it with having the efficiency, for that purpose, of 24 inches of solid brick.

Thanks to the courtesy of the engineers of the Solvay Process Company, I am also able to give you at this time a comparative statement of the relative cost of these two classes or types of chimneys. Chimneys with heavy walls and of the same size, that is, of the same flue area, which they build, and of which they have built quite a number, have cost, they tell me, about $7,800. This stack cost about $3,500.

I have given you practically all the essential details connected with its construction, and the photographs tell the story of its efficiency and stability as against wind storms. [Applause.]

In answer to this question, "What effect will frost have upon the porous tile which you use for the inner lining of the stack?", I will refer to a report made in December, 1881, by a committee of the Massachusetts Charitable Mechanic Association, who subjected this material, with others submitted in a competitive test of fire proofing materials, to a series of fire, water and frost tests. The material was then known as "Loring's Porous Terra Cotta" and was the only material that withstood all these tests successfully, thereby proving itself to be fire, water and frost resisting. This porous material is now extensively manufactured and used in many parts of this country. It is becoming well known as the most reliable fire proofing material and is largely used in fire proof building construction.

Extracts from the Report of the "Exhibition of Massachusetts Charitable Mechanic Association, Boston, September, 1881.

BUILDING MATERIALS AND CONSTRUCTION.

Judges: JOSEPH HAM, JOHN EVANS, HUGH F. MEANY.

Exhibit No. 1482, S. E. LORING and T. A. JOHNSON, Boston, Mass.—Porous Terra Cotta: Drawings and Photographs illustrating Loring's Method of Fire-proofing, and Test of Material; Model of Roof, Floor and Wall Construction. The Material used, for covering iron, etc., combines non-conductibility with indestructibility. The non-conductibility is due to its porosity; the indestructibility to the fact that it is composed of a fine clay, with no other ingredients. On account of its porous and elastic nature it is not liable to be cracked by sudden cooling produced by throwing on of water. A highly commendable invention, and worthy of great credit.

Silver Medal.

The Honorary Committee in charge of building materials and construction, desirous of practically testing some of the fire-proof materials displayed in the above exhibit, asked Messrs. JOHN S. DAMRELL, inspector of public buildings of Boston, WILLIAM A. GREEN, chief engineer of the fire department of Boston, OLIVER L. SHAW and EDWARD ATKINSON of Boston, to act as judges in a trial to be made in an open lot near the exhibition building. The positions were accepted, and the

tests were made under the conduct of Mr. FRANK E. KIDDER, an engineer and at that time an instructor in construction at the Institute of Technology.

The test was a severe one, and reflects credit on Mr. KIDDER; and for details of the manner of conducting the test we would refer to Mr. KIDDER'S report. We have examined the remains of the building, showing the condition of the materials after the test.

The question of safety of property against loss by fire becomes one of great importance when we realize the fact that a hundred *million of dollars' worth are annually swept out of existence in this country alone by the fire fiend. This loss is mainly chargeable to the present methods of building construction; and the question how to resist these terrible inroads on the wealth of our nation should occupy the best thought that can be employed, and we should welcome and encourage any effort in the direction of safety, and the introduction and use of materials which when exposed to heat and frost, will prove impervious to the action of either.

No building can be fire-proof unless the constructive parts of the interior are protected by fire-proof materials and as far as possible by a non-conductor of heat. Walls of masonry should only be used as an enclosure for these constructive points.

Buildings may be protected and partially fire-proofed, using posts, columns, and girders of wood or iron, thoroughly encased in a fire-proof material, these holding firmly together and supporting the principal parts of the interior and exterior, and rendering such buildings less liable to fall in case of fire, and leaving them in condition to repair at a relatively small expense. We regard as essential qualities in a perfect material for general use in fire-proof building construction the power to successfully resist disintegration by the action of fire, water and frost.

Loring's porous terra-cotta, as tested, has satisfied us that this material can be made to possess all these qualities. A perfect sample when cut resembles pumice-stone, the substance being well-burned clay; the porosity increases its power as a non-conductor, and enables it to resist sudden and extreme changes of temperature without liability to fracture; renders the body penetrable so that nails, screws, or other metallic fastenings can be driven into it to secure it to or about the constructive

* The fire loss in the United States was nearly $165,817,810 in 1901.

framework which it covers or protects; or to attach slate, tile, or other weather-proof covering to this material, when used as a substitute for ordinary wall, floor or roof sheathing. It also increases its power of suction, making it the best possible material for receiving plastic cement, asphalt, etc., when used with these and other materials for the exterior and interior groundwork and finish.

We have examined Mr. LORING'S drawings, showing his proposed methods for using this and other materials in building construction. They involve in some cases radical changes in the ordinary methods of utilizing building materials and in our opinion they are thoroughly practical and economical, and can be profitably used by every one interested in erecting safe and permanent buildings.

They show earnest and intelligent work by one who has carefully studied the nature of the destructive power of fire, water and frost, and their methods of attacking ordinary building materials and methods of construction; and they clearly indicate to us that by seeking to develop and use the best qualities of each material, he has finally combined them in the constructive portions of buildings, making them in a simple, efficient and economical way, proof against destruction by these elements. The terra-cotta, submitted to these tests, gave evidence in a remarkable degree, of its ability to protect iron beams and columns from the action of fire and water without fracture or disintegration, as well as to insure the complete security of wood from the action of the flames, so that not the least charring was observed where it was protected by Loring's porous terra-cotta.

Signed,

JOHN S. DAMRELL,
WILLIAM A. GREEN,
OLIVER L. SHAW,

Committee.

SECOND SESSION.

WEDNESDAY AFTERNOON, APRIL 23, 1902.

The Association met in Chipman Hall at 2 P. M., President FISH in the chair.

The PRESIDENT. We will proceed to the reading of the first paper on the programme, Hydraulic Compression of Air, by Mr. W. O. WEBBER, C. E., of Boston.

Mr. W. O. WEBBER. Mr. President and gentlemen of the New England Cotton Manufacturers' Association, I wish to state in presenting this paper that I am not here as the representative of the Compressed Air Company; I am simply here as a private consulting engineer interested in dynamical questions, having been employed by the Compressed Air Company on some of their experimental and installation work, and thought that this subject might be of interest to you gentlemen who are such large users of power. I also wish to state that I am not tied up to any particular kind of power. I do not think that compressed air is going to do away with steam or electricity. I find that the larger part of my practice today is with steam, and then with electricity, and the smallest part with air.

*HYDRAULIC COMPRESSION OF AIR.

WILLIAM O. WEBBER, C. E., Boston, Mass.

The use of compressed air for power purposes and as a means for the transmission of power is much older than is usually conceded. It was used by SMEATON in 1786, by MEDHURST in 1810, by RENNIE in 1812, by VALLANCE in 1818, at the Triger Mines of Challones in 1845, by CUBITT in sinking the piers of the Rochester bridge in 1851. BRUNEL also made a similar use of it at Saltash in 1854. It was also used by BRUNEL on the Thames Tunnel, by BARLOW on the Thames Subway and in the shaft of the Marie Colliery in 1856.

Air has been transmitted for considerable distances and under a great range of pressures. At the Mont Cenis Tunnel, air was transmitted to the boring machinery 20,000 feet, under a pressure of 105 pounds per square inch. In the installation at Paris in 1881, by M. POPP, the length of the pipes slightly exceeded twenty-four miles. This plant, as well as the one installed by the same person in Vienna in 1877, was originally used for the running and regulating of clocks, but it afterwards developed into power for working small motors. In Paris the main is a steel pipe 20 inches in diameter, and the air, maintained at 90 pounds pressure, transmits 6,000 horse power.

At a large compressed air plant at Offenbach, near Frankfort-on-the-Main, air is distributed through 25,000 feet of cast iron

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* For further reference on this subject see Transactions as follows:
Transmission of Power by Compressed Air, ZACHARIAH ALLEN, Vol. 10, p. 30.

pipe under 90 pounds pressure. At the Portsmouth Dock Yards, England, air is transmitted through 14,000 feet of pipe, varying from 3 to 12 inches in diameter, under 60 pounds pressure, and is used to drive forty 7-ton capstans, five 20-ton cranes and machinery for working seven caissons.

There is also a large compressed air plant at the Terni Steel Works in Central Italy. In this plant 1,200,000 feet of air per day, under 75 pounds pressure, are used to drive a 100-ton hammer, a 100 and 150-ton crane and numerous engines.

In this country 2,500,000 cubic feet of air per day, at 60 pounds pressure, delivering 1,700 horse power, are used at the Chapin mines in Michigan. The mains in this plant are 24-inch wrought iron pipes, one-quarter inch thick. Very successful compressed air tramways have been operated for a number of years at Berne, Switzerland, and at Nantes, France.

MEKARSKI used compressed air for driving tramway cars in 1877.

In all of the above-named uses of compressed air the compression was produced by steam-actuated mechanical compressors. The older ones were all simple compressors, MEKARSKI being the first to use compound compressors, and he was followed in this line by NORTHCOTE in 1878.

The adaptability of compressed air for various uses is very great. While electricity supplies power and light very directly, it cannot be used for heating excepting at a prohibitive cost. Gas is used very directly to supply heat, power and light, but is expensive for heating and power at the prices generally charged. City water pressure can be used to supply power, and indirectly light, by the use of a water motor driving a dynamo, but is too expensive for most purposes. Steam supplies heat and motive power almost directly, and indirectly light through a dynamo. It is, however, more expensive than compressed air, and involves more risk and attention. Compressed air can be used directly as a source of motive power, ventilation and refrigeration; also in the operation of elevators. It is particularly advantageous to use in storehouses and warehouses for the operation of the

elevators and any other machinery which it may be desirable to locate in such a building, owing to the fact that there would be no danger of its freezing up and there would be no necessity of keeping the building warm in consequence, and also from the fact that there would be no fire risk due to pipes coming in contact with wood work as might be the case if steam pipes were used.

In fact, with enclosed self-oiling bearings, compressed air would offer the only practical power which might be used in the interior of a powder magazine.

We have already mentioned its use in connection with power hammers, cranes and motors. For drying purposes it is even more efficient than heat. Compressed air is also largely susceptible to double uses. For instance, after it has been used cold, or without preheating expansively in a motor to produce power, the exhaust furnishes an efficient and cheap method of producing refrigeration. When pre-heated and then used through a motor the exhaust is still hot enough to contribute considerably to the heating of a building.

In the transmission of compressed air over long distances, the loss of pressure due to friction in pipes of proper sizes, and the loss due to leakage in properly constructed pipes and joints, are very small. Velocities of from 30 to 50 feet per second are allowable. When an air distribution system is introduced into a thickly settled community, the safety from the air main is very much greater than from a steam main or a water main under pressure and the leakage or even the bursting of such a pipe is attended with very much less damage.

Another great advantage in such a case is that power users require no new plant, and need incur no outlay for motors. Their present steam engines, with little or no alteration, are admirably adapted for serving as air motors.

Tests of small motors of from one to two horse power, using air at the ordinary atmospheric temperature and at 735 pounds per square inch absolute, exhausting at from 33 degrees to 54 degrees, required a consumption of 1,200 cubic feet of air per

brake horse power per hour. At the Berne tramway the air is compressed to 450 pounds per square inch. On the average the cars use about 35 pounds of air per car-mile. This, however, was used in connection with hot water. In small motors of from one to two horse power, with the air pre-heated to a temperature of about 158 degrees and exhausting at about the freezing point or 32 degrees, 850 cubic feet of air per brake horse power per hour were used.

In some very carefully conducted trials made by Professor RIEDLER, using an 80 horse power engine which was actually giving 72 indicated horse power, using air at 80 pounds pressure, heated to 320 degrees, with cylinders jacketed with hot air and exhausting at about 95 degrees, about 425 cubic feet of air per brake horse power per hour were used. This showed an efficiency of about 92 per cent.

Practically all that has been said above refers to air compressed by the old methods of mechanical compression. We now come to the subject of air being compressed directly by falling water or under pressure. Air compressed by the ordinary methods of mechanical compression contains at least the same amount of moisture as the surrounding atmosphere from which it was compressed; and, in parting with the heat necessarily contributed to the air by mechanical compression, it is inclined to absorb more moisture. There is incidentally a considerable loss of energy in parting with this heat. Air compressed directly by falling water is kept at the same temperature as this water. It is compressed isothermally, and the consequent expansion, when used in motors, produces an almost truly adiabatic expansion line. Tests, however, have shown that air compressed in this manner contains only one-sixth of the moisture originally in the surrounding atmosphere from which it is compressed. This is probably because the moisture in the bubble of air is pressed or squeezed out to its surface and then absorbed by the surrounding water. Incidentally there is no loss of power in parting with any heat, and there is a practical result which is of more importance — the hydraulically compressed air can be expanded down

to a temperature much below the freezing point, while atmospheric air, with the usual amount of moisture, mechanically compressed, cannot be used at all, owing to the freezing up of the exhaust passages of the motor in which the attempt to use it is being made.

During some tests made at Magog in September, 1899, owing to the condition under which these tests were made, the change in the humidity in the air was not so great as above stated. The moisture in the external air showed 90 per cent. of saturation, and after compression, 29 per cent., or a little more than one-quarter. In the Magog tests, using an old 75 horse power Corliss engine, with air at 53½ pounds gage pressure, with cold air direct from the compressor at from 66 degrees to 73 degrees and exhausting down to the extremely low point of 42 degrees below zero, 850 cubic feet of air per brake horse power per hour were used; and with the air pre-heated to from 205 degrees to 295 degrees Fahrenheit, and exhausting at from 67 degrees to 68 degrees, 620 cubic feet of air per brake horse power per hour were used.

Probably one of the oldest applications of the use of water power to the wants of man was a form of hydraulic air compressor which operated as an entrainment apparatus. (See figure 1). This was the well known water bellows or trompe of the Catalan forges.

This apparatus, briefly described, consisted of a bamboo pole, disposed at a slight inclination from the perpendicular, into the upper end of which a stream of water was led, entraining air with it in its downward passage. The low end of this bamboo pole was introduced into a bag made of the skin of some animal, the air being allowed to escape from the water into the upper part of the bag, whence it was led by pipes or truyeres to the forge, the water being allowed to escape from the lower edge of the bag. From this original device a great many improvements have been worked out, and besides this a number of other forms of hydraulic air compressors, or of compressors using other liquids for compressing air or other gases, have been designed.

Another form of apparatus (see figure 2) is fully described in

FIG. 1. ASSYRIAN WATER BELLOWS, 300 A. D.

Kircher's Mundus Subterraneous, Vol. IV, p. 223; and Vol. X, p. 195; and in Kercher's Musurgia Universalis, Vol. II, pp. 310-347.

One of the first inventions carrying out this idea, figure 3, was made by Mr. J. P. FRIZELL, of Boston, Mass. His invention made use of an inverted syphon having a considerable horizon-

FIG. 2. ROMAN WATER BELLOWS, 1545 A. D.

FIG. 3. FRIZELL'S AIR COMPRESSOR.

tal run D between the two legs A and B. A stream of water was led into the upper end of the longer leg A, and at the top of the horizontal run D between the two legs of the syphon was provided an enlarged chamber C in which the air separated from the water. The water was then led off from the lower part of this air chamber and passed off through the short leg B of the syphon, the pressure of the air accumulated in the air chamber being therefore due to the height of water maintained in the shorter leg of the syphon. This application of carrying upward the water, after the air was separated from it, so as to produce a considerable pressure upon the air, seems to have been original with Mr. FRIZELL, and in this feature his device differs from the old trompe.

Mr. FRIZELL made two working models of this type of apparatus. In the first the legs of the syphon were 3 inches in diameter, the head of water being 25 inches, and an efficiency of 26½ per cent. was obtained. A larger apparatus was then constructed at the Falls of St. Anthony, on the Mississippi River, a few miles above St. Paul. The longer leg of the syphon in this plant was 15 inches by 30 inches and the short leg of the syphon 24 inches by 48 inches in section. The height of water above the air chamber was 29 feet. The head in feet varied from 0.89 to 5.2, the first head being just sufficient to cause a flow through the pipes. The working head varied from 2.54 feet to 5.02 feet and the efficiency from 40.4 per cent. to 50.7 per cent. the quantity of water in these cases varying from 5.92 to 11.89 cubic feet per second.

From his experiments Mr. FRIZELL estimates that with a shaft 10 feet in diameter, a depth of 120 feet and a fall of 15 feet, the efficiency would be 76 per cent., and that with a head of 30 feet and a fall of 230 feet, the efficiency would be 81 per cent.

Another device, figure 4, differing somewhat from that of Mr. FRIZELL, was invented by A. BALOCHE and A. KRAHNASS in 1885, and consisted of a syphon B carrying water from an upper to a lower reservoir, the lower end of the syphon being pro-

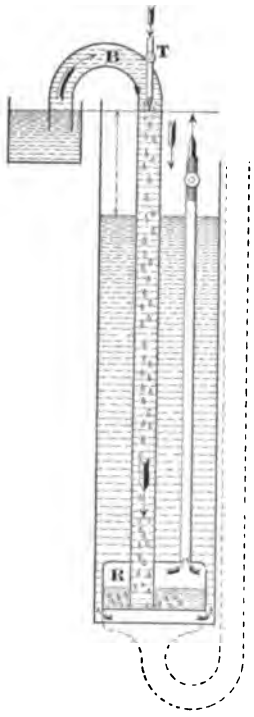

FIG. 4. BALOCHE AND KRAHNASS AIR COMPRESSOR.

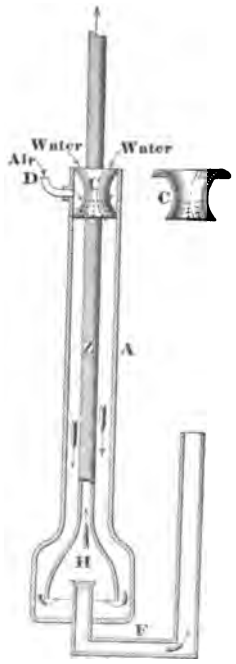

FIG. 5. THOMAS ARTHUR AIR COMPRESSOR.

jected through an inverted vessel R placed nearly at the bottom of the second reservoir. Just beyond the bend of the syphon and in line with the axis of its longer leg, an air pipe T projected into the descending leg of the syphon, thus entraining the air with the descending column, which carried it down into the inverted chamber R, from which the air escaped at the top, while the water passed out from the bottom into the lower reservoir. This apparatus produced pressure on the air in the top of the inverted chamber, due to the heighth of the water column upon it.

Another device, figure 5, patented by THOMAS ARTHUR in 1888, differs from the last in having a stream of water led directly

into the top of the vertical pipe A. Inserted into the mouth of this pipe was a double cylindrical cone C forming an annular air passage between it and the walls of pipe A.

Owing to the increase in the velocity of the water in passing through the narrow throat of the double cone, air is inhaled through the pipe D through the annular space mentioned and through perforations in the lower cone, and is entrained with the falling water.

Through the downflow pipe A rises a vertical delivery pipe Z for the compressed air, having its lower end H enlarged and open at the bottom. Projecting upward into this enlarged air-delivery pipe was a water escape pipe F through which the water passed after having parted with the air. The escape pipe was in the form of an inverted syphon and maintained on the air in the delivery pipe Z a pressure due to the elevation of the water at its discharge point above the air line in the large end of the delivery pipe.

A number of other patents on apparatus of this type were issued to CHARLES H. TAYLOR, numbers 543, 410, 543, 411, 543, 412 July 23, 1895. His inventions, figure 6, consisted principally of a down-flow passage having an enlarged chamber at the bottom and an enlarged tank at the top. A series of small air pipes projected into the mouth of the water inlet from the large chamber at the upper end of the vertically descending passage, so as to cause a number of small jets of air to be entrained by the water, TAYLOR seemingly having been the first to introduce the plan of dividing the air inlets into a multiplicity of smaller apertures evenly distributed over the area of the water inlet.

TAYLOR at first seems to have attempted to utilize centrifugal action in causing the separation of the air from the water in the larger chamber at the bottom of the compressed air column; but he afterwards abandoned this scheme and used, instead, deflector plates in combination with a gradually enlarging section of the lower end of the downflow column in order to decrease the velocity of the air and water and cause partial separation to take place. The deflector plates changed the direc-

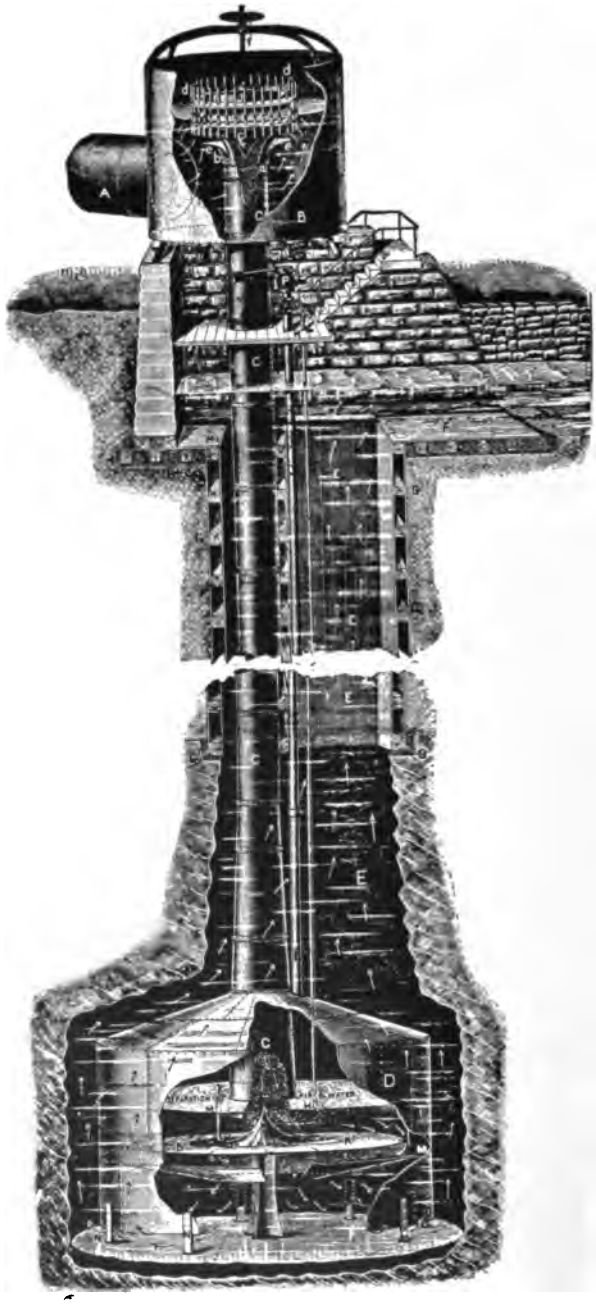

FIG. 6. CHARLES H. TAYLOR AIR COMPRESSOR.

tion of flow of the water. This was evidently intended to facilitate the escape of the air.

The latter improvements on this device have been in the method of introducing the air into the mouth of the downwardly flowing water column, so as to insure the largest proportion of air being taken down with the water, and in methods of decreasing the velocity of the combined air and water at the bottom of the descending column, causing the water to part more readily with the air, the water then passing out at the bottom of the enlarged chamber into an ascending shaft, maintaining upon the air a pressure due to the height of water in the uptake, the air being led off from the top of the enlarged chamber by means of a pipe.

The first of these compressors on the TAYLOR principal was installed at Magog, Quebec, to furnish power for the print works of the Dominion Cotton Mills Company. The head of water is 22 feet; the downflow pipe extends downward through a vertical shaft 10 feet square in cross section and 128 feet deep. At the bottom of the shaft the compressor pipe enters a large tank, which is known as the air chamber and separator.

A series of very careful tests made by Prof. C. H. MCLEOD on August 7, and August 13, 1896, and again on September 10, 11 and 12, 1899, by Professors MCLEOD and DURLEY of McGill University, Montreal, Quebec, J. HERBERT SHEDD of Providence, R. I., JAY M. WHITAM of Philadelphia, Pa., TAYLOR GLEAVES of Lynchburg, Va., and the writer, demonstrated that with 19.5 feet head, using 4,292 cubic feet of water per minute, was recovered the equivalent of 1,148 cubic feet of free air per minute, which would represent 248 cubic feet of air per minute compressed to 53.3 pounds pressure, showing that out of a gross water horse power of 158.1, 111.7 horse power of effective work in compressing air was accomplished, giving therefore an efficiency of 71 per cent.

In the tests at Magog we recovered 81 horse power, using an old Corliss engine without any changes in the valve gear, as a motor; this would represent a total efficiency of work, recovered from the falling water, of 51.2 per cent.

FIG. 7. MAGOG AIR COMPRESSOR.

When the compressed air was pre-heated to 267 degrees Fahrenheit, before being used in the engine, 111 horse power was recovered, using 115 pounds of coke per hour, which would equal 23 horse power. The efficiency of work recovered from the falling water and the fuel burned would be, therefore, about 61½ per cent. On the basis of Prof. RIEDLER'S experiments, requiring only 425 cubic feet of air per brake horse power per hour, when pre-heated to 300 degrees Fahrenheit, and used in a hot air jacketed cylinder, the total efficiency secured would have been about 87½ per cent.

The second compressor on the TAYLOR principle is located on Coffee Creek, to the South of Ainsworth, British Columbia. The available head of water is 107.5 feet. The shaft is 210 feet deep. The maximum volume of water is 4,200 cubic feet per minute and would represent, at 71 per cent. efficiency, 587 horse power. The compressor is expected to utilize 5,100 cubic feet of free air per minute or 734 cubic feet of compressed air at 87 pounds pressure, and give an air motor horse power of 360 horse power. It is possible, however, that this plant may not give as high percentages as this, as the water passages are of smaller areas than those at Magog.

FIG. 8. TAIL-RACE AT MAGOG.

Three other plants are now under construction — one at Peterborough, Ontario; one at Norwich, Conn., and one in the Cascade Range, State of Washington. The plant at Peterborough, Ontario, for the Government of the Dominion of Canada, is to be used in connection with one of the locks on the Trent Valley Canal, the chief dimensions being as follows: head of water, 14 feet; gage pressure, 25 pounds; depth below tailrace, 64 feet.

The whole plant is enclosed in the masonry wall of the lock, the usual rock chamber in the bottom of the shaft being built in concrete and only a foot below the lower water level of the lock.

At Norwich, Conn., at what is known as the Tunnel Privelege on the Quinebaug River, the plant will give 1,365 horse power of air at a pressure of 85 pounds per square inch. The head of water is 18½ feet; depth of shaft, 208 feet.

The air will be transmitted a distance of four miles with a loss in transmission not exceeding 2 per cent., through a 16-inch pipe, which will be laid with flanged joints and rubber gaskets.

The plant which is being constructed in one of the canyons of the Cascade Range of mountains in the State of Washington will give 200 horse power of air at a pressure of 85 pounds per square inch. Head of water, 45 feet.

There is no shaft, as the apparatus is constructed against the vertical walls of the canyon. The capacity of the plant is based on 2,000 miner's inches of water, equal to 53.2 cubic feet per second. The total height of this apparatus is about 260 feet.

Of course where steam is required for manufacturing purposes, such as dyeing, scouring and finishing of textile fabrics, the steam used in this manner can be used for power without any additional cost. Where these manufacturing processes are never required nor necessary, a form of power which dispenses with the burning of coal is so much the more desirable.

This subject naturally divides itself into two or three branches.

First, as to its practicability.

Second, as to its efficiency, and

Third, as to its original cost and relative economy.

FIGURE 9.

FIGURE 10.

The first question as to its practicability is best answered by the fact that a plant on this principle was built at the factory of the Dominion Cotton Mill Company, Limited, at Magog, P. Q., in the spring of 1897, where it has been in successful operation ever since, for driving the engines in the printing department of their calico print works, where it entirely replaced steam.

Under the second heading of efficiency, an estimate of the power available from a waterfall by different methods of development would be as follows:

Given horse power of water,	1,000 horse power.
Wheels at 85% efficiency,	850 " "
Shafting, pulleys and belts at 80%,	680 " "

or a total net result of 68%. wheels being at full gate and allowing the minimum loss for friction of shafting.

FIG. 11. DISCHARGE AT MAGOG.

With wheels as usually run at part gate, the results would be as follows:

Given horse power of water,	1,000 horse power.
Wheels at 75% efficiency,	750 " "
Shafting, pulleys and belts at 50% (average),	375 " "

or 37½% of the whole power; both of the above being directly at the site of the water power.

In order to transmit power to a distance, we must take again:

Horse power of water,	1,000 horse power.
Wheels at 85% efficiency,	850 " "
Generators at 92% efficiency,	780 " "
Transformers at 92% efficiency,	720 " "
Line, at 95% efficiency,	680 " "
Converters at 92% efficiency,	625 " "

or about 62½% of the whole.

and direct connected with motors at 90% efficiency,	565 " "

or 56½% of the whole, or if belted at 90% efficiency, 508 " "

say 51% of the whole.

By the use of an hydraulic air compressor:

Horse power of water,	1,000 horse power.
Hydraulic compressor at 75% efficiency,	750 " "
Pipe line efficiency at 98%,	735 " "
Pre-heating dry air adds 50% / Moistening dry air adds 50% } = 100%,	1,470 " "
Air engines or motors at 78% efficiency,	1,145 " "

or 114½%.

and if belted at 90% efficiency,	1,030 " "

or 103% of the whole as a resultant effect.

The weight of a cubic foot of compressed air at 85 pounds and at 70 degrees Fahrenheit, equals .58.

One thousand horse power would represent 750,000 cubic feet of 85-pound air per hour; this would equal 382,000 pounds of air, and as one pound of air will absorb .58 pound of water. we would require 221,500 pounds of water per hour. The labor represented by forcing 221,500 pounds of water per hour, equal

FIG. 12. TAKING HOOK GAUGE MEASUREMENTS, MAGOG.

to 3,700 per minute, against 85 pounds pressure, equals 195.5 feet would be $\frac{195.5 \times 3700}{33{,}000}$ equals about 22 horse power, and as pumps give an efficiency of 50 per cent., equals 44 horse power of work by pump, or 4.4 per cent. of the whole 1,000 horse power. This is therefore to be deducted. The coal used in heating the air, which is about one-half pound per horse power per hour, would also represent an amount of work equal to 75 horse power, or 7½ per cent. of the whole 1,000 horse power. This added to the 4.4 per cent. as above would equal an amount of 13 per cent. to be deducted, equals 87 per cent. of the whole horse power, or $1{,}030 \times .87 = .896$, or 89.6 per

cent. as a final result of all, as against 56½ per cent. by electricity, or 68 per cent. by water wheels at their best, or 37½ per cent by water wheels at the average.

That our results are within the bounds of reason is shown by the fact that 75 per cent. × 98 per cent. × 200 per cent. × 78 per cent. × 87 per cent. = 99.5 per cent.

Under the third heading of the cost of a plant and the economy of operation, in order to compare the cost of water power, compressed air, electricity and steam, it is necessary to consider them first as located directly at the point of consumption, then as transmitted to a distance, say of four (4) miles, and possibly at greater distances.

The elements entering into all of the considerations except steam, are flowage rights and dams. These two items vary so much as to make any results obtained in consequence only approximate, but by assuming the same conditions they may be considered comparable.

(1) Assuming, therefore, the value of water and flowage rights to be —

For 5,000 horse power,	$50,000 00
we would have a constant charge of	
Interest at 5% on $50,000.00 =	2,500 00
Taxes at 1% " =	500 00
or an annual charge of,	$3,000 00

(2) Also a dam to control 5,000 horse power of water under a head of 45 feet, costing for masonry dam, forebay and penstock:

5,000 horse power at $9.00 =	$45,000 00
and involving a constant charge of	
Interest at 5% on $45,000.00 =	2,250 00
Taxes at 1% " =	450 00
or an annual charge of	$2,700 00

(3) Considering first a water power plant consisting of turbine wheels, directly connected by shafting to a mill or factory, to develop 5,000 horse power of water under 45 feet fall:

Eight 48-inch water wheels (in pairs),	$8,000 00
Cases, shaft, tubes, etc.,	4,000 00
Wheel house including foundations and tailraces,	7,500 00
Governors, shafting, etc.,	2,500 00
Adding item (1) flowage rights,	50,000 00
" " (2) dam,	45,000 00
Makes the total cost of installation,	$117,000 00

The resulting effective horse power, wheels being operated at full gate and with minimum loss of power in friction of shafting, etc., equals (shafting 20 per cent. × wheels 15 per cent.) 3,400 horse power or 68 per cent., making total cost of installation per net effective horse power $34., which is relatively cheap owing to the high fall. The cost of installation at Atlanta, Ga., being $90., at Columbia, S. C., $72., and at Concord, N. H., $42. per average horse power.

The annual cost of an effective horse power under above conditions would be, therefore:

Interest on $117,000.00 at 5%,	$5,850 00
Taxes on $117,000.00 at 1%,	1,170 00
Depreciation on $10,500.00 (wheels and shafting) at 5%,	525 00
Depreciation on $8,000.00 (penstock and cases) at 2%,	160 00
Repairs on $60,000.00 (dam, wheels, cases, etc.) at 2%,	1,200 00
Insurance on $60,000.00 (dam, wheels, cases, etc.) at 1%,	600 00
	$9,505 00
Operating expenses, 2 men at $2.50 per day for 365 days,	$1,825 00
Supplies, oil, waste, etc., per annum,	175 00
	$2,000 00
Making a total of,	$11,505 00

Which on a basis of 3,400 net horse power, would equal $3.38 per horse power per annum.

(4) Considering now an hydraulic air compressing plant directly at a mill site, using cold compressed air without pre-heating, we would have:

Metal work for 5.000 horse power compressor,	$12,000 00
Excavating rock shaft 3,000 cubic yards at $5.00,	15,000 00
Erecting compressor in place,	15,000 00
5,000 horse power of air engines at $7.00 per horse power,	35,000 00
	$77,000 00
Adding item (1) flowage rights,	$50,000 00
" " (2) dam,	45,000 00
Making the total cost of installation,	$172,000 00

The losses being 25 per cent. in compressor and 22 per cent. in air engines, the net result would be 2,920 horse power, making an installation cost per horse power of $59., which is still cheaper than most water wheel developments, though more than our figures above.

The annual cost of this power would be as follows:

Interest on	$172,000.00 at 5%,	$8,600 00
Taxes	172,000.00 " 1%,	1,720 00
Depreciation	35,000.00 " 5%,	1,750 00
Repairs	35,000.00 " 2%,	700 00
Supplies	35.000.00 " 1%,	350 00
Insurance	35,000.00 " 1%,	350 00
		$13,470 00
Operating expenses, 2 men $2.50 each for 365 days =		$1,825 00
Total annnal expenses,		$15,295 00
and for 2,920 horse power would equal,		$5 25

as the annual cost of an effective horse power using cold air.

(5) If, however, the compressed air is pre-heated just before being used in the air engine or motor, an economical result is arrived at by —

An additional cost of,	$15,000 00
For a pre-heating plant involving 15% for fixed charges amounting to,	$2,250 00
And fuel for pre-heating at $1,00 per horse power per year,	5,000 00
Making an increased annual expense of,	$7,250 00

But as this additional expense increases our effective power to

5,000 horse power again, the total cost per horse power per annum is $4.51, instead of $5.25, an increase of efficiency cost of 15 per cent.

(6) We will now consider the question of an electrical development to be used directly at the dam. The water rights, dams, penstocks, wheels, governors, etc.,would be the same as —

In case (3) *i. e.*,	$117,000 00
To this must be added,	
Three 1,000 K. W. generators,	32,000 00
Exciters,	1,800 00
Switchboard and lightning arresters,	2,400 00
4,000 horse power of motors,	80,000 00
Wiring to motors,	8,000 00
Making a total of,	$241,200 00
For 3,000 horse power of net result this would equal, per horse power cost of installation.	$80 50
This would involve extra fixed expenses of,	
Interest on $124,200.00 at 5%,	$6,220 00
Taxes " 124,200.00 " 1%,	1,242 00
Depreciation 112,000 00 " 5%,	5,600 00
Repairs 112,000.00 " 2%,	2,240 00
Insurance on 124,200 00 " 1%,	1,242 00
	$16,544 00
And additional attendance of 2 men at $2.50 each =	$1,825 00
And extra supplies, oil waste, etc.,	300 00
Total annual expense (Case 3),	11,505 00
Fixed charges (Case 6),	16,544 00
Additional operating expenses (Case 6),	300 00
	$30,474 00

Which on a basis of 3,000 horse power net effective result, would give a cost per horse power per annum of $10.16 for electricity.

Comparing these figures with the cost of steam power as given by the best authorities as follows, for large 1,000 horse power plants under the most economical conditions:

Dr. Charles E. Emery,	$23 11
F. W. Dean,	22 24
Samuel Webber,	23 90
Average,	$23 25
We obtain an electrical horse power for,	$10 16
Water at,	3 38
And a compressed air horse power from the same source,	5 25
Average of compressed air and water power,	$4 31

Or less than one-quarter the cost of steam power and about one-half the cost of electrical power.

It is entirely feasible to transmit compressed air for power long distances at not prohibitive costs for pipe lines.

At Mont Cenis Tunnel air is transmitted 20,000 feet, or four (4) miles under 105 pounds pressure.

In Paris the Popp system of pipes slightly exceeds 24 miles in length and is a steel pipe 20 inches in diameter, and the air maintains 90 pounds pressure and transmits 6,000 horse power.

At Frankfort-on-the-Main, Germany, air at 90 pounds pressure is used through 25,000 feet of cast iron pipe.

At Portsmouth Dock Yards in England, air is transmitted through 14,000 feet of pipe ranging from 3 inches to 12 inches in diameter at 60 pounds pressure.

And in this country, besides the plant now under construction at Norwich, Connecticut, where 1,385 horse power will be transmitted through four (4) miles of 16-inch cast iron pipe at 85 pounds pressure from the falls of the Quinebaug at Preston, Connecticut, to Norwich, Connecticut, and at Peterborough, Ontario, and Ainsworth, B. C.; 1,700 horse power are used daily at the Chapin Mines in Michigan, through 24-inch pipe one-quarter (¼) inch thick.

(7) We will now assume a transmission of power by compressed air to a distance of four miles, the air being passed through the pipe line cold and dry. Five thousand horse power of compressed air at 85 pounds pressure per square inch and a velocity pf 60 feet per second, would require a 20-inch pipe, costing $350. per 100 feet, laid with couplings, therefore —

Four (4) miles = 21,120 feet of 20-inch pipe at $3.50 per foot would equal,	$73,920 00
This sum at 5% interest, 1% taxes, 1% depreciation, or 7% in all would represent,	5,174 40
Which divided by 2,920 horse power (Case 4) would represent,	1 75
Per horse power to be added to the cold air cost of,	5 25
Making a total cost of,	$7 00
Or dividing by 5,000 horse power (Case 5) would represent,	$1 035
Per horse power to be added to the pre-heated air cost of	4 51
Making a total cost of,	$5 545

Per horse power per annum for air power four (4) miles from its source.

(8) Considering electrical transmission four miles from source of power, there would have to be added to the costs already given in Case 6:

Copper wire (four miles),	$6,000 00
Poles, arms, insulators, etc.,	1,500 00
Labor erecting,	500 00
Step-down transformers for 3,000 K. W.,	15,000 00
Switchboard,	2,400 00
Making a total of,	$25,400 00

Interest on $25,400.00 at 5% =	$1,270 00
Taxes " 25,400.00 " 1% =	254 00
Depreciation 15,000.00 " 5% =	750 00
Depreciation 10,400.00 " 2% =	208 00
Repairs 15,000.00 " 2% =	300 00
Repairs 10,400.00 " 1% =	104 00
Making a total of,	$2,886 00

For annual expense, equal to $0.96 per horse power per annum.

This added to Case 6, would give $11.66 per horse power per annum as the annual cost of electric power, four miles from its source by water power.

If compressed air were to be transmitted to a distance of, say, 20 miles, we would use a pressure of, say, 125 pounds per square inch, at a very small additional cost of construction as follows:

158 yards of extra excavation at $5.00 =	$790 00
94 feet in length of extra downflow pipe, erected =	2,256 00
Making a total of,	$3,046 00

Which, with interest and taxes at 6% would add only six cents (6c.) per horse power per annum to our cost for Case 4.

This would enable us to use a 16-inch pipe for our transmission line, costing $240.00 per 100 feet laid.

This for twenty (20) miles = 105,600 feet at $2.40 per foot =	$253,440 00
Which at 7% for interest, depreciation and taxes would be	5 90
Per horse power per annum to be added to Case 4,	5 25
Together with the interest and taxes as above,	06
Would equal,	$11 21
For cold air and for pre-heated air,	10 47

As annual costs per horse power per annum twenty (20) miles from source of power.

And with electricity under a twenty (20) mile transmission, we would have to add the figures already given in Case 6, $10.16.

Step-up transformers for 3,000 K. W.,	$15,000 00
Wires, poles and labor 20 miles,	40,000 00
Step-down transformers,	15,000 00
Switchboard,	5,000 00
Making a total of,	$75,000 00

On which the annual expenses would be:

Interest on $75,000.00 at 5% =	$3,750 00
Taxes " 75,000.00 " 1% =	750 00
Depreciation 30,000.00 " 5% =	1,500 00
Depreciation 45,000.00 " 2% =	900 00
Repairs 30,000.00 " 2% =	600 00
Repairs 45,000.00 " 1% =	450 00
Making a total of,	$7,950 00

Per annum, equal to,	2 65
Per horse power per annum, on a basis of 3,000 net effective horse power. This added to Case 6,	10 16
Would give,	$12 81

Per horse power per annum for electricity twenty (20) miles from source of power.

These figures show conclusively that while water power for direct consumption at the site of the waterfall is the cheapest known form of power, yet for transmission purposes hydraulically compressed air offers a means of transporting power and giving results cheaper than electricity, and that both electrical transmission and compressed air transmission from water powers are cheaper than steam power.

The compressed air transmission also has a further advantage in the fact that in order to utilize it it is not necessary to go to an expensive outlay for electric motors, as the compressed air can be used directly in steam engines without requiring any alteration to be made in them.

There would, however, be the resulting loss of power due to the friction of shafting, which involves one of the greatest savings consequent on the use of electric power, although it would be possible to subdivide power and put small air motors in place of electric motors on each machine or the individual lines of shafting, in which case the expense would be about the same. If anything, however, in favor of the small air motors.

A great deal of data which is too technical to be of interest in an article of this sort, can be found in the reports of the Popp Air system in a paper by Prof. RIEDLER, published in Paris in 1891, and also by M. SOLIGNAC, Paris, 1893, and is also given in the published volume of the Howard Lecture, delivered before the Society of Arts in London in 1893 by Prof. WILLIAM C. UNWIN, Chapters IX and X.

The PRESIDENT. Gentlemen, are there questions to be asked — anything to be said in reference to this paper of Mr. WEBBER'S?

Mr. WILLIAM D. HARTSHORNE. Mr. President, I would like to ask for an explanation of some of the figures, if Mr. WEBBER will be kind enough to give them. Some of the figures on page 192, besides the one which you called attention to, seemed to be a little obscure; I do not quite understand them. You say: "The coal used in heating the air, which is about one-half pound per horse power per hour, would also represent an amount of work equal to 75 horse power, or 7½ per cent. of the whole 1,000 horse power." And a little further back there is a similar statement, on page 186: "When the compressed air was pre-heated to 267 degrees Fahrenheit, before being used in the engine, 111 horse power was recovered, using 115 pounds of coke per hour, which would equal 23 horse power." That is something I do not quite understand.

Mr. W. O. WEBBER. I see the point Mr. HARTSHORNE makes. What we did there was this: we found by experiment, and REIDLER and UNWIN also found by experiment, that the amount of fuel necessary to produce an additional horse power in air was from three-quarters of a pound to one pound per horse power per hour. But what I have taken here representing power — of course I could not take the measure of air, because I would be measuring my efficiency by the thing I was working with, so that what I have done there is where I have taken one pound of fuel per horse power per hour to pre-heat, 1,000 horse power of air, I have taken that one pound of fuel as representing so many horse power if you were converting it into steam horse power, because that is the known measure that we have. That is the kind of measuring cup we have. In other words, if you force the 221,500 pounds of water, against air at 85 pounds pressure, that would be equal to pumping it up against a head of 195.5 feet, which would represent 22 horse

power in work done. Now it would take 44 horse power of steam to do 22 horse power of pumping water, because the usual run of pumps of that type and efficiency is only about 50 per cent. That 44 horse power, of course, then would be 4.4 per cent. of the whole 1,000 horse power that you are going to put the water into.

Now the fuel is taken in the same way. That one pound of fuel would represent so much horse power of steam if it was used in making steam, and the amount of fuel necessary to raise 1,000 horse power of compressed air from the normal temperature up to 270 degrees would represent 75 horse power if that same amount of fuel was used to convert water into steam, which I have therefore called 7½ per cent. That is what you have got to deduct.

Mr. WILLIAM D. HARTSHORNE. Pardon me once more, if you please, Mr. President; I do not quite understand the relationship stated between one pound of coal, and the 75 horse power. It would look as though, if the 75 horse power was all you got out of 1,000 pounds of coal, it was not a very economical means of getting power. Perhaps I am wrong in my understanding.

Mr. W. O. WEBBER. No, I think perhaps where you are led astray, Mr. HARTSHORNE, is this: the amount of heat which you have to get out of the 1,000 pounds of coal in order to produce 1,000 horse power of steam would be the heat necessary to raise the water from a normal temperature up to the temperature of steam at some given pressure, and it takes a great many heat units to do that — more than it would to raise air from say 60 or 70 degrees to 270 degrees. You require only about 200 degrees to raise air, whereas it requires all that greater excess to raise water from the normal temperature of water to the temperature of steam at some given pressure.

Mr. WILLIAM D. HARTSHORNE. Pardon me once more, please; I do not quite get it yet. We have here a consumption

of 1,000 pounds of coal and a realization of 75 horse power. It seems to me that if that amount of coal was burned under a steam boiler and thus produced the steam put through an engine, it would realize nearer 750 horse power.

Mr. W. O. WEBBER. The only reply I can make is that the coal as I have figured it out, and as I understand it, sufficient to heat 1,000 horse power of compressed air 200 degrees would only represent about 75 horse power if you were using that same coal in the usual way of heating water into steam. You cannot take the most economical methods in figuring that, of course; you cannot say that you are going to get 1 horse power of steam for 2 x 3½ pounds of coal, because that only takes your actual work in a very efficient boiler alone. The usual conditions, you know, take anywhere from seven to eight pounds of coal per horse power per hour, taking all of your conditions in, taking your pumps and everything else into consideration.

The PRESIDENT. If I understand it, the only question Mr. HARTSHORNE raises is how many horse power you can get from 1,000 pounds of coal.

Mr. W. O. WEBBER. That depends so entirely upon circumstances that you cannot make any absolute answer to it. I have seen it require 15 pounds of coal per horse power per hour to a plant, and I have also seen a plant run on 2.46 pounds. That is the best figure I ever saw on a whole plant.

The PRESIDENT. Gentlemen, we will proceed to the next paper — the time is flying,— Flyers, by Mr. FAY H. MARTIN of Boston.

FLYERS.

FAY. H. MARTIN, Boston, Mass.

The function of a fly frame flyer as commonly used at the present day, as all cotton mill men know, is to rest upon the tapered top of a spindle and twist the strand of cotton which is delivered to it and lay the same upon a bobbin. A small thing in itself, but it plays a very important part in the manufacture of cotton goods.

It is very difficult to trace the flyer in its early stages and the origin of its invention. The inventors themselves were too busy and too unaccustomed to the use of the pen to commemorate the fruits of their genius, and the writers of the day were unconscious of the great revolution in the industry that was silently proceeding. The very few authors who have since touched upon the subject, finding the material so scanty, have compiled brief and most unsatisfactory notices.

The inventor of the mode of spinning by rollers is ascribed to JOHN WYATT of Birmingham, England, who in 1733 made a model upon which was spun the first thread of cotton ever produced without the intervention of human fingers. The principle of this machine was to use rollers to draw the sliver to three, four or five times its former length and degree of fineness; after passing through the second pair of rollers, the reduced sliver is attached to the spindle and fly, the rapid revolution of which twists it into a thread and at the same time winds it upon a bobbin. This is the first mention of a flyer. Other inventors in this line were LOUIS PAUL and THOMAS HIGHS, but it remained for RICHARD ARKWRIGHT, in 1768 and the following years, to

perfect and reduce to a practical form the ideas of these and other inventors, as well as his own, and to him we must give the credit of very high inventive talent, as well as an unrivalled sagacity at estimating at their true value the mechanical contrivances of others.

The flyers upon ARKWRIGHT'S original machine in 1769 were made of wood, with small wires on the side which lead the thread to the bobbin; the arms were solid and without pressers. These flyers were not adapted to the spinning of roving but were for warp yarn. ARKWRIGHT, on his roving frame, allowed his roving to be deposited in revolving cans which supplied the necessary twist. About the year 1817 the fly frame was introduced for preparing roving for the middle and coarser numbers of both warp and weft. Instead of the revolving cans of the roving frame, the fly frame had spindles placed at equal distances from each other, with a fly on the top of each, one of the arms being made in the form of a tube for the purpose of receiving the roving and conveying it to the bobbin.

About the year 1820 the presser, or pressure finger, was applied to the flyer, which by its action compresses the material upon the bobbin upon which it is being wound, thus enabling a much larger quantity to be put upon them than would otherwise be the case. Before the application of these the bobbins were filled very quickly, and the operation of doffing was necessary three or four times, while once is now quite sufficient Formerly the bobbins had flanged heads in order to retain the roving upon the barrel, but these were long ago dispensed with. The roving, as it is now wound upon the bobbin, being coned at both extremities, the presser forms a guide which enables this to be done in conjunction with the action of the taper motion on the frame.

Since the introduction of the presser upon flyers, a great deal of thought and study has been applied to the perfection of them, and over three hundred patents have been allowed on flyers alone, each inventor, in most cases, striving to equalize the pressure on the roving as it is wound upon the bobbin. The action

of the presser has been confined to centrifugal force and springs, with the main thought to reduce the friction at the bearings of the presser, so as to get the full benefit of the centrifugal force.

No radical change was made in the form of the flyer since the first, all forms having the hollow arm, or tube, extending down the full length of the traverse, until 1894, when THOMAS F. DUNN conceived the idea of cutting the arms off half the length and hanging a presser in such a manner as to form a continuation of the hollow arm. This changed the presser from a centrifugal one to a centrifugal and gravity presser combined, also lightening the weight of the flyer about 25 per cent. at the same time. Another important feature about the new flyer is the reduction of friction upon the roving,; as all manufacturers are aware, it is very beneficial to have as small amount of it as possible.

In the attenuation of the sliver from half hank to four, five and six hank in the roving, it will be obvious that when the strand of cotton has been attenuated to this degree and not having received more than two or three turns of twist per inch, its cohesive power is of the smallest degree, and the most perfect adjustment of winding process to the delivery of the rove by the front rollers is necessary to prevent strain or breakage; so that all the friction that can be eliminated from the flyer will help to make a stronger roving and reduce breakages to a minimum. Take the present form of flyer with the roving entering the hollow arm at the top, the centrifugal force throws the strand of cotton against the outside of the arm so as to form a bearing all the way down, and when it arrives at the bottom it makes a very abrupt turn and is then wound twice around the presser finger in such short spirals that the centrifugal force has no chance for action to reduce friction.

In the new flyer this is overcome to a great extent; the roving enters the short hollow arm, then out upon the presser, around which it is wound twice, then down until it reaches the foot, where it makes a very easy turn to the bobbin. The action of centrifugal force upon the roving when it is upon the presser

arm tends to relieve the friction, which it does to a certain extent. This enables the making of very soft and even roving. This reduction of friction is so noticeable that a change has to be made in the location of the cone belt towards the small end of the driven cone, as the bobbin must be driven faster to take up the slack in the roving, which was taken care of before by so much surface contact on the old form of flyer. Also, a change of three or four teeth in the tension gear has to be made at the same time, so as to move the cone belt a less distance at each change of the rail. The reason for the change in the tension gear is that the roving being delivered to the bobbin in a softer condition, the layers are flattened to a more elliptical form, which enables more layers to be placed upon the bobbin in a given diameter. To illustrate this, you will take two strings and twist them together, then pull at each end, and you will notice that the strain has a tendency to set the twist and make the string hard, which will retain its roundness, but apply less strain, it will be softer and allow of compression. The present form of flyer applies this strain and sets the twist, while in the new one there being less friction, therefore less strain, the roving is delivered to the bobbin in a softer and more even condition.

Increased production is the result with these new flyers from this feature alone, while they being 25 per cent. lighter and supplied with short arms which do not spread, enables the speed to be increased from 10 to 15 per cent. without material increase in power or repairs. In regard to the spreading of the arms, it does not occur in most mills, and why? Ask any mill superintendent or overseer how their flyers are running, and the answer is almost invariably, "All right. No bother at all; once in a while a presser gets knocked off or broken, but otherwise all right." The reason for this answer is this: the machine builders and cotton manufacturers know from experience at what speed flyers can be successfully run so as to give the maximum production at minimum repairs, but you will find that at the speed the frames are now running, the bill for pressers being knocked off amounts to quite an item at the end of the year. In the new

flyer the arms do not spread, and consequently the pressers do not strike adjacent flyers, which means a reduction in repairs at that point. Increased diameter of bobbin can also be obtained on the same spaced frame, which will lengthen the time between doffs; also, the help claim where these flyers are being used, that they are easier to handle and piece up.

The evolution of this form of flyer from its conception has been about the same as all other inventions of merit; the inventor did not have the means to develop it and was afraid of losing it, so that it slept for a number of years, until the attention of the writer was called to it. Shortly afterwards the writer obtained control of the patent and entered upon its development. Since then it has been improved and brought to a practical form, so that it is now ready for use. The skill required in the construction of flyers is such that the building of them is a specialty in that branch of mechanics devoted to the manufacture of cotton machinery; so much so that they are only successfully made by firms devoted to the building of them exclusively. They require the closest attention to the minute details, so that the one thousandth flyer will be just the same in every respect as the first one. If they do not receive this attention, when they are placed upon the fly frames a decided difference at individual spindles will be noticed. This skill is such that it is only acquired after years of practice. One large builder of flyers told the writer that there were forty-three operations in the process of making their flyers, and that they did not have a man in their employ who could build a complete flyer; but each man was an expert at the particular operation that he was on, and that they had to make their men, as it were, to fill the places. As I said at the first, the flyer is a small thing in itself, but when looked at from every point of view it increases in size and importance. Although it now fills its place without much complaint, this is no reason why it always should remain without improvement. In this age of progress it is bound to come, not only in flyers alone, but in every other branch as well.

The PRESIDENT. Are there any questions to be asked of Mr. MARTIN? If not, we will proceed to the next paper, Knots and Knot Tying, by ROBERT C. WEBSTER.

KNOTS AND KNOT TYING.

ROBERT C. WEBSTER, Boston, Mass.

The subject of knots and knot tying has been a problem for cotton manufacturers as long as cotton mills have existed.

While a comparatively small and unimportant process, the spooling department is probably the source of as much trouble as any department in the mill. A bad knot causes trouble from the warper to the cloth room. Articles almost without number have been written suggesting as many different ways of doing away with the evil. Many patented and experimental appliances have been put in operation without practical or economical success. These mechanisms have not been successful on account of their being either too costly to operate, or not doing the work properly, the great objection being that the work of the machine was such that no uniformity of length of ends was maintained.

In England, for many years, the manufacturers have claimed to tie weaver's knots. This does not, however, do away with the trouble, as it is as possible to leave a long end to a weaver's knot as it is to a spooler's knot. In the United States some mills have attempted to tie the weaver's knot. However, it is impossible to be sure that the knots are all short end weaver's knots.

Some time ago I was in a mill that claimed to tie weavers' knots exclusively. The superintendent took me to their spooling department, and standing in one corner of the room, we had a good opportunity to watch the spooler tenders. The girls near us were all tying weaver's knots, but glancing across

FIG. 1. POORLY TIED KNOTS.

the room, I saw several girls industriously tying spooler's knots. I called the superintendent's attention to this, and he readily admitted that it was only while the operatives were being watched that weaver's knots were tied.

He said he did claim, though, that by paying the girls more than the other mills paid he was sure that if they did not tie a weaver's knot they would tie a good spooler's knot. He also had a system of marking the work so that he could trace a bad knot back to the girl who tied it.

Much has been claimed for the weaver's knot in preference to the spooler's knot. The actual knot is very slightly smaller,

FIG. 2. MACHINE TIED KNOTS.

but the great trouble from knots does not come from the knot itself, but from the long ends. Yarn tied with a short end spooler's knot will weave a better piece of cloth than yarn tied with weaver's knots when the ends vary in length.

Some two years ago a device was invented and shortly after marketed, that was intended to do away with bad knots. This machine ties a spooler's knot with short, even ends. Mills that have adopted this machine claim that a saving can be made in the cost of spooling of from ten to twelve per cent. This, however, while a large item, is not the greatest advantage of such a machine. From tests made in a mill, we found that a section

beam could be filled from half an hour to an hour sooner than a section beam on which hand-tied work was being run.

The great saving, however, is neither in spooling or warping, but in the weave room. When a knot with a long end attempts to pass through the reed it almost invariably causes a break and the broken ends become entangled in the threads near it, and often seven or eight ends are broken before the trouble is discovered. Probably more than 95 per cent of the seconds caused by imperfect knots can be obviated by the use of proper mechanism.

On the Draper loom from eight to ten minutes per day is required by the weaver in filling a 24 bobbin hopper. With twenty-warp thread breaks per day, estimating the time required to find thread, draw in, and start the loom at one and a quarter minutes, a weaver would be required to give each loom twenty-five minutes per day to tying-in ends and ten minutes per day to fill the hopper, making a total per loom of thirty-five minutes. In a ten hour day a weaver could thus operate sixteen looms and be employed 560 minutes out of the 600.

By reducing the number of breaks in the loom from twenty per day to five per day, a weaver could increase the number of looms from sixteen to thirty-two. On a plain loom the reduction of warp thread breaks would enable a weaver to increase the number of looms he could take care of, though the increase would not be as great as the figures given above.

Mr. C. H. DRAPER has given me the following results of a test he made some time ago. The test covered the running of from four to ten looms for two or three months. The total running time, adding up that of each of the looms separately, was 378 days of 10 hours each. The number of warp ends broken was 3,641, out of which 1,722 were caused by bad knots. In the same time there were 731 stoppages due to slack threads, out of which 486 were due to bad knots. From these figures we find that 47 per cent. of warp breaks, 65 per cent. of slack threads, and 50 per cent. of these two faults added together, were due to bad knots. In these tests the looms were equipped with various kinds of

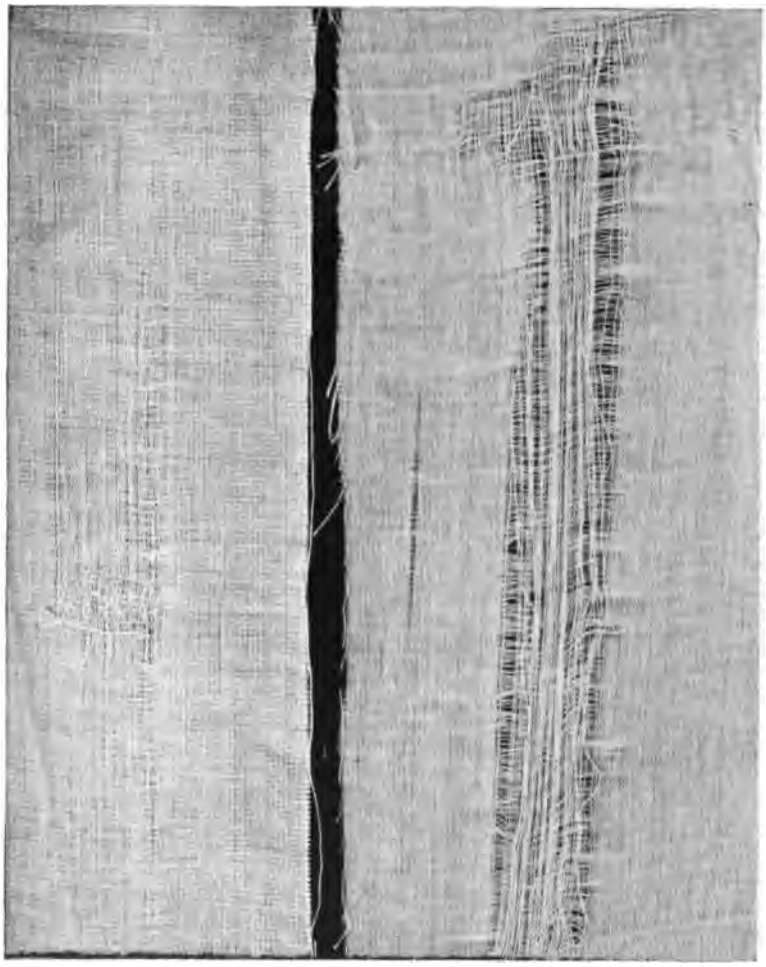

FIG. 3. EFFECT OF POOR KNOTS IN THE CLOTH.

mechanical stop motions made by the Draper Company and the cause of the trouble was in each case accurately noted down on the spot. Most of the slack threads caused by knots, and a large proportion of the warp breaks caused by knots, were due to the long, trailing ends left by the spooler tender.

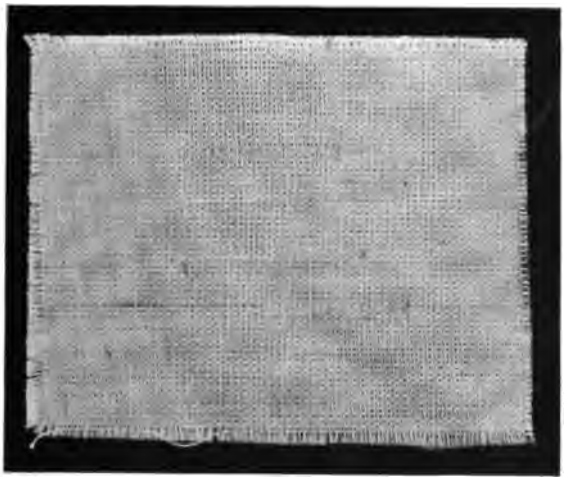

FIG. 4. CLOTH WOVEN FROM MACHINE TIED YARN.

Cut number one shows some bad knots taken from the warp. Number two illustrates some machine tied knots. The difference is quite apparent. Number three shows the effect of bad knots in the cloth. Number four shows a piece of cloth woven from yarn tied by machine.

If this machine will do away with bad knots, the work of the warper can be increased, and the capacity of the weave room increased, and at the same time the number of seconds reduced. As to whether it will do it or not, we will leave for the manufacturers to say.

The PRESIDENT. This is a question of considerable importance, gentlemen, the tying of knots. Are there any questions to be asked of Mr. WEBSTER? If not, we will pass to the next paper, Thread Boards and Guides for Wet Twisting, by LEWIS T. HOUGHTON of Worcester.

THREAD BOARDS AND GUIDES FOR WET TWISTING.

LEWIS T. HOUGHTON, Worcester, Mass.

Your Board of Government has considered a paper on Thread Boards and Guides, read at the last September meeting of the Association,* to be of such interest as to request a resumé and extension of that paper.

That this subject of thread boards and guides has received but little attention in the past is shown by the fact that the thread boards and guides now in general use are practically the same as those used 50 years ago.

The attention of those interested in cotton spinning machinery has evidently been directed to other improvements. For today spindles are not only running at double the speed which not long ago was considered the limit, but they are run with one-half the power then used, while the spinning rings, generally considered necessary to be held stationary, now ***whirl in the air.*** at unlimited speed, in perfect unison with the spindle, and incredible as it may seem, spindles have been running steadily for the past four years without one drop of oil, and have caused no trouble, and show no signs of wear, while the thread boards and guides have remained the same as those used years ago. Why this neglect of the thread guide, can only be surmised, for it is just as necessary for spinning as a spindle or ring, and any imperfections of the guide will cause trouble, just as quickly as imperfections in the ring on spindle.

The breaking of ends is a matter that should receive the care-

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* Thread Boards and Guides, LEWIS T. HOUGHTON, Vol. 71, p. 245.

ful attention of the cotton spinner, especially with the high speed that is now considered essential for economical production. There are many causes for broken ends, and many of them may be easily remedied; such as badly worn rings or spindles, or their imperfect adjustment; grooved or badly set thread guides. Probably some fault of the thread guide is the cause for a large portion of the broken ends that occur today, as the rings and spindles, as they are now made, are very near perfection, while the same old thread board and guides, with all their imperfections, are still used.

I think it will be generally conceded that the nearer round the rings are, the less breaking of yarn and travelers, and without any attempt for relief, millions of spindles are running today under conditions that cause broken ends just as quickly as a ring would that was badly out of round. Such a ring would be thrown away very quickly.

The practical cotton spinner, to obtain the best results, would require the best spindles and rings obtainable, and have the thread guide deliver the thread *exactly* over the *center* of the *spindle*. Of all the spindles in the world that are now running, the per cent. that have the *thread delivered exactly* over the *center* of the *spindle* is very small, simply because it is practically impossible to adjust the thread guides in general use exactly, as one turn of the guide out or in, one-sixteenth of an inch, is the limit to their adjustment. One-sixteenth of an inch either way from center makes one-eighth of an inch difference from the opposite sides of the ring, and this variation of guide from the centre, has just the same action on the thread and traveler as a ring would that was so much out of round.

A ring one-sixteenth of an inch oblong would be very quickly discarded, while the thread guides are used right along, without complaint, simply because they are adjusted *as well as they can be.*

The benefit of perfect adjustment can be easily demonstrated by trying to spin with poor roving or fine numbers of yarn on the average spinning frame. Probably one could spin with

a three square ring and a guide that delivered the thread anywhere, *provided* the *yarn* and *traveler* were *strong enough.*

Many times the traveler, ring, spindle, or poor roving are blamed for the fault of a badly adjusted thread guide. An instance lately came to my notice. A mill had some roving that broke so badly they could not use it. For an experiment, four spools of this roving were tried on some thread guides that were adjusted exactly, with the result that two doffings were spun from this poor roving with only one broken end.

That form of guide which has an end extended to form a thread arrester, is the cause for many broken ends, unless it is held in right position. For if this arrester is not in right position, it either fails to arrest the end when a thread does break, and lets the end whip around and break down the adjoining thread, or it catches and breaks a thread that is running all right. I have seen many spindles in succession put out of business for this reason. The thread arresters were out of their proper position, and I was told by the overseer that it was a common occurrence.

Many mills do not use this form of guide because it is so liable to become displaced, and the consequent occurring loss. Some mills employ a man whose whole time is spent in looking after the adjustment of thread guides, and many of the mills I have seen would keep a man pretty busy.

I was in a spinning room not long ago where the Pontiac guide was used. The arrester ends were standing at all angles, and yet the overseer was anxious to bet fifty dollars that there was not a guide in his room that was not perfectly adjusted. *He thought so,* and there was no use in pointing out to him that there was but *one position* in which the arrester served its purpose the best.

I have here a section of thread board, recently taken from a mill, and there are thousands more running there today just like it (or worse, as the superintendent said), and there are many other mills with thread boards in practically the same condition as this sample; and the stockholders wonder why the earnings

are not larger. An examination of this sample would furnish them with an idea.

The grooving of guides is another cause for broken ends, and is undoubtedly the reason for the so-called vibrating guide, in regard to which there is such a wide difference of opinion among expert cotton spinners. The only point on which they agree is, that the vibrating thread prolongs the wear of the guide. Its advocates also claim that this vibration permits the twist to run up to the bite of the roll better. This last claim is denied, for while the vibration one way is with the twist, the opposite vibration is against the twist, and the gain one way is offset by the opposite vibration.

The advocates of the vibrating guide do not seem to have a very clear case on this point. Those opposed to this guide claim that the gain made by the longer wear of the guide is lost many times over by the greater breakage of travelers and the extra and uneven wear of the rings, caused by this vibration. If this last claim is correct, here is a clear case of saving at the spigot, and the claim seems to be warranted, for if a ring that is oblong will cause more breaking of travelers, and wear more uneven than a round one would (and I think this is generally conceded), then the vibrating thread guide is justly condemned, for it causes the same uneven, jerky motion upon the thread and traveler that an oblong ring would, especially so when the ring is at the top of the traverse.

Would it not be of considerable interest to have this question settled by an exhaustive test in some of the textile schools, where preconceived opinions would not prejudice the result of the trial? I have talked and corresponded with expert cotton spinners on this matter and feel convinced that the vibrating thread guide should not be used if the best results are desired.

I have taken more time, perhaps, than was necessary in referring to some of the well known causes for broken ends, in order to clearly show some of the indispensable requirements for a satisfactory thread board and guide.

First. Thread boards should allow *easy* and *accurate adjust-*

ment of the *guide*, for if this adjustment is not easily done, "pretty near" will have to answer.

Second. *Permanence* of adjustment. When the guide is once *accurately adjusted*, it should require no more thought or care of the overseer, who has enough to think of without watching the thread guides.

Third. The thread board should also be so *constructed* as to allow *easy renewal* of *guide* when worn, and *hold* the new guide as *solid* as a new board would.

Fourth. I would have durability. A thread board should be so strongly made, of such *material*, as to *last* as long as the *frame*, *without* any *repairs*.

Fifth. The guide should be of some *hard material* to prevent grooving.

Sixth. Cleanliness. The thread boards should be made of some material that is easily cleaned and cared for.

There can be no question as to the desirability of the requirements; the only question there can be is in regard to a thread board that fills them. I have here some samples of a thread board which were designed to meet these requirements, and the general approval with which they have been received warrants the claim that they do.

In wet twisting, the conditions are quite different from spinning, yet the requirements of a thread board for twisting are the same as for spinning, with the added complications caused by the action of water, which they have to meet. Nickeled brass seems to be the most suitable material for the thread board, as wood or steel are quickly injured by the action of water, and plain brass soon becomes sticky and hard to clean. While the thread guides may be, and are, made from brass wire, it wears out so quickly that it is not very desirable for this purpose. Steel rusts so easily, and enamel wears off so quickly, that porcelain seems to be the most desirable material for a thread guide in wet twisting. One serious objection to the porcelain guides now in use has been, no adjustability, and this one thing, lack of adjustment, is probably the cause for 50 per cent. of the breakage

in wet twisting. I have seen a twisting frame with over 75 per cent. of the spindles out of business, and the thread winding up on the rolls. This frame was fitted with porcelain guides that were badly worn, and the thread was delivered *considerably* off from the the *center* of *spindle*, which was, evidently, the cause for so much breakage of thread.

This matter of thread guide adjustment has never received the attention it should, probably for the reason it has been so difficult to obtain especially on twisting frames, where porcelain guides are used.

The methods that are usually adopted for adjusting the guides central to the spindle do not ensure of exact adjustment and a better method should be devised.

I will not occupy any of your time in describing the construction of these thread boards, which will be more readily understood by an examination of some samples that I have here for both spinning and twisting, which you are invited to critically examine. I thank you for your kind attention and hope that all of you will profit by the saving that is sure to follow the use of a perfectly adjusted thread guide.

The PRESIDENT. We will now pass immediately to the reading of the next paper, The Whittum Metallic Thread Board, by RICHARD THACKERY. This will be read by Mr. P. T. CREED.

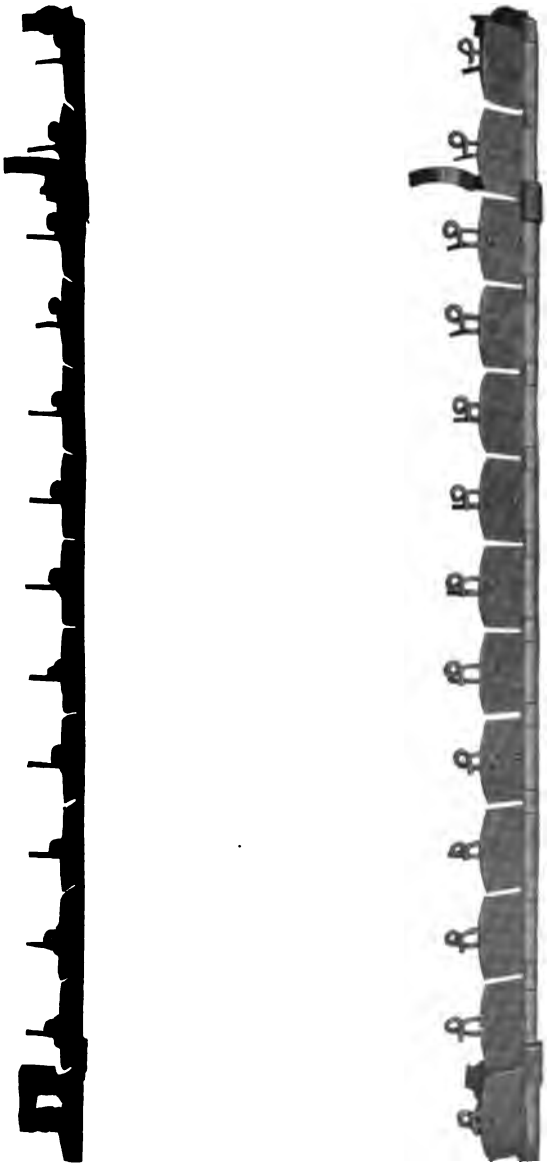
*THE WHITTUM METALLIC THREAD BOARD.

RICHARD THACKERAY, Fall River, Mass.

I do not propose to take up a great deal of your time in talking about metallic thread boards. In fact, I do not see as there is much more to say on the subject than my esteemed friend, Mr. LEWIS T. HOUGHTON, has already said, but I will just draw your attention to the construction, lifting and dropping devices of the Whittum thread board, also the manner in which the thread guide is held. As you will notice on examination of the model, the board is made entirely of steel, and the plates or metal blocks are so formed that they hinge upon a nine-sixteenths inch round rod, and can be turned up or dropped down. The turning down of the board is accomplished by a very clever and simple little device which can not get out of order, and the catch cannot be knocked out, thereby letting the board down while the frame is running, as the whole board has to be raised up before the catch can become disengaged and the board dropped down.

Dropping the thread board instead of raising it while doffing, is practically a new idea, and it gives the doffer a clear view of what he is doing, as the threads are carried away from the top of the bobbin, and the doffer can take hold of the bobbin farther down than he could if the board was turned up. This, as you are all well aware, tends to decrease the liability of pulling the yarn over the end of the bobbin, or, as the spinner would say, making snotty-nose bobbins, which means a saving of waste.

* For further reference on this subject see foot note on page 216.



THE WHITTUM METALLIC THREAD BOARD.

Also, when the board is dropped down and away from the top of the bobbin, and when the bobbin is raised from the spindle in the act of doffing, it leaves just one turn of yarn at the base of the spindle, and placing the empty bobbin on the spindle binds the turn there, and when the bobbin is again raised in the process of doffiing, then that turn comes off with it and a new turn is laid on in the same place.

In so removing the turn of yarn that is laid on the spindle in the act of doffing, there can be no waste left on the spindle to get inside of the bobbin to hold it up and also making waste, as is the case when the board is raised for doffing. By throwing the catch out, the board can be raised up the same as any ordinary board.

The manner in which the thread guide is fastened is very simple, as the underneath plate that helps form the hinge is fastened to the top plate by means of a slotted screw, and tightening the screw clamps the guide wire securely against the top plate, and owing to the peculiar construction of the underneath plates the guide wire cannot possibly be moved.

By slackening the screw, the guide may be pushed in, drawn out, or swung around in a lateral motion, which permits the thread guide to be adjusted over the center of the spindle to a nicety.

Any style of guide wire can be used with equal facility as the one shown in the model, but your attention is especially drawn to the one used.

In conclusion, will say that by so constructing this thread board entirely of steel, a perfectly straight board is obtained, and all tendency to twist and warp, as is the case where a wooden strip is used, is entirely overcome, and no trouble whatever is found in setting the guide wire a uniform distance from the point of the spindle. This thread board can be furnished and put on to spinning frames or twisters.

The PRESIDENT. Gentlemen, we will discuss these two papers together if there are any questions to be asked. Mr. HOUGHTON has his models here, and the Whittum board is on the table before you. If any members would like to examine these boards they may step this way and look them over.

If there are no questions to be asked we will now take a recess until tomorrow morning at 10 o'clock.

THIRD SESSION.

THURSDAY MORNING, APRIL 24, 1902.

The Association met in Chipman Hall at 10 A. M., President FISH in the chair.

The PRESIDENT. Gentlemen, if you will please come to order. The first paper on the programme is, A New Combing Machine, by JOSEPH NASMITH of Manchester, England, which will be read by the Secretary.

*A NEW COMBING MACHINE.

JOSEPH NASMITH, Manchester, England.

For many years the process of combing as applied to cotton has remained in a stationary position and it almost seemed as if the last word had been said by HEILMANN. It is true that detailed improvements in the machine have rendered it a much more efficient instrument mechanically than when first introduced, but in principle and action it remains substantially unchanged. This is not a matter for surprise in view of the experience gained. In spite of many attempts to break away from the Heilmann construction, no other method of dealing with cotton was anywhere nearly so successful in its results. For it must be remembered that combing is resorted to in all cases as a means of producing a yarn of superior quality, and it does this by placing the fibres of the material treated in parallel order and approximately equal numbers throughout, and by removing those below a defined length. The Heilmann machine was so constructed as to perform these objects effectively, and the principle of combing one end of the lap first, then seizing the combed ends of the fibres and joining them to the previously combed material, so that each joining is similarly made and tufts of equal length successively removed from the lap, has long been recog-

* For further references on this subject see Transactions as follows:
Bourcart's Combing Machine, BENJ. ALFRED DOBSON, Vol. 44, p. 69.
Discussion of Double Nip Comber, Vol. 57, p. 104.
Waste of Comber, HERBERT E. WALMSLEY, Vol. 61, p. 141.
The Use of the Comber in Cotton Manufacture, E. W. ATKINSON, Vol. 61, p. 162.
New Methods of Combing Cotton, H. G. MCKERROW, Vol. 69, p. 341.

nized as the most successful method of obtaining the evenness and uniformity so essential in a combed sliver.

It speaks volumes for the soundness of Heilmann's conception that, although half a century has passed since the introduction of his machine, it has had till now no serious rival in dealing with cotton. This is the more remarkable because the limitations of the machine are well known. It is not successful in combing cotton below a certain well defined length; it produces a large quantity of waste; and is complicated and difficult to manipulate. In spite of these faults, however, no machine based upon any other method of manipulation has been so successful in operation, and all of the machines which have been recently put on the market fail to produce a sliver as clean, as even, or giving as strong and glossy a yarn as that made by the Heilmann machine. An increased production may indeed be claimed, but it is obtained at the expense of the quality of the delivered sliver, and of the strength, evenness and brilliancy of the resulting yarn. Furthermore, in nearly every machine with which the writer is acquainted, the improvement in production is accompanied by a complication of the mechanism used, which is undoubtedly a step in the wrong direction.

It is the object of the present communication to draw attention to a new machine invented by the writer's brother, Mr. J. W. NASMITH, in which, while retaining those features of the Heilmann machine to which its success is due, certain improvements of a radical character have been made. While the *quality* of the combed sliver is fully maintained the *quantity* produced is largely increased, and in addition, the range of staple which can be combed is considerably enlarged, whilst the waste is brought under more complete and easier control. That these claims are not extravagant can be demonstrated by an inspection of a machine built upon a Heilmann frame with the improvements introduced which is in the hands of Mr. STEPHEN C. LOWE of Boston. It is obvious that any machine that breaks the fibre, makes bad piecings or creates waste, however large its production, is of no value if a good, even, strong, silky and

brilliant yarn is wanted. The underlying ideas in the present case were to so simplify the mechanism that it should work with less effort and be more easily adjusted, while producing in larger quantity a sliver quite as clean and with piecings quite as good, if not better, than those made on the Heilmann machine, and with a minimum of waste. It is claimed that the inventor has fully succeeded, and that the new machine is much more simple in its mechanism — only one cam being used throughout — the parts are more accessible and more easily set; the speed of the cylinder is no greater than in the ordinary machine; the quantity of waste removed can be regulated at will more easily and quickly; cottons with any staple from seven-eighths of an inch upward can be treated with equal facility; while the production of the Heilmann can be easily doubled. Further the new machine can be made with any desirable number of heads worked from one point either at the end or in the centre of the machine. It will perhaps be the most convenient course to deal with the operation in stages and point out the changes which have been made and their effect upon the result.

The central organ in the combing machine, round which all the others are built, is the cylinder. Experience has shown that it is not desirable that the surface speed of the cylinder should be too great, whether that arises from either an increase in its revolutions or of its diameter. In the case of the new machine the speed of the cylinder is unaltered, the only difference in construction being that, as a new method of detaching and piecing is adopted, the fluted segment is done away with and a smooth filling up piece substituted. The only function of the cylinder is to comb the end of the lap and this work is rendered lighter by the operation of the nipper in a way to be described.

In the Heilmann machine the feeding of the cotton, the opening and closing of the upper nipper, the entrance and withdrawal of the top comb, and the operation of the detaching rollers, are each the work of separate cams which have to be individually adjusted relatively to each other. In the Nasmith machine the only cam which is used is one to give the alternate backward

and forward rotation of the detaching rollers, all the remaining parts being operated simply and effectively through a reciprocal movement of the nipper frame given by a crank fixed on the cylinder shaft.

The nipper of the Heilmann machine has a very limited movement. It consists of two parts: a frame, hinged on a pivot carrying the lower or cushion plate, and normally supported by the pull of two powerful springs, and a second frame, hinged on the first and carrying the upper nipper plate, being oscillated by means of a cam. The upper jaw is forced by the cam on to the lower one, and comes in contact with it at a comparatively high speed, thus giving a kind of hammer blow (which is very destructive of the leather covering the lower plate) and instantly transfers the full force of the springs from the top screws to the nipper cam. In addition to this, the force required to oscillate the whole nipper, in order to lay the fibres in the needles, is very considerable, each of the springs sustaining the nipper having a pull of about 20 pounds or 40 pounds per head. Unless care is taken it often happens that the cushion plate is pushed on to the comb needles damaging both the covering and the needles, because the arc of oscillation, if continued beyond a certain point, intersects the path of the needles, a defect also present in other machines.

Beyond this slight oscillatory movement, the nipper of a Heilmann machine is stationary, and plays no part in any other operation than that of combing, gripping the fibres while the needles are passing through the end of the lap. In the new machine it possesses many other functions and is quite differently constructed and applied. The nipper plates, feed roller, and top comb are all borne on a double frame, which is centred at a suitable point, and is given a reciprocal oscillatory motion by means of a crank fixed on the cylinder shaft. The pins on which this frame is hinged are so fixed that the arc followed by the nose of the nipper is a very flat one, and departs as little as possible, during the period of oscillation, from the periphery of the cylinder which it never intersects, consequently, once set to

the gauge the nipper cannot be made to touch the needles, no matter how far it moves. It will be easily understood that, as the oscillation of the frame is derived from the rotation of a crank running at 100 revolutions per minute, it will be practically, if not theoretically, continuous, although the rate of movement will of course vary at different periods of the rotation of the crank. It has been found that this characteristic lends itself admirably to the working of the machine, the mechanism being smooth and ensuring easy running.

The bottom nipper plate is fastened to a transverse bridge piece on the nipper frame, and hinged to this bridge are the arms to which the top nipper jaw is attached. The top nipper frame is ordinarily acted on by springs which tend to keep it closed, but it has a rearward arm carrying a small runner, which, during the forward oscillation of the nipper frame engages with a fixed bracket and thus opens the nipper. The position and shape of this bracket is such that the nipper closes easily and gently at the right moment with a sort of rolling contact in marked contrast to the blow given by the Heilmann nipper. In effect it is found that it is quite unnecessary to provide either the top or the bottom nipper jaw with a leather covering to form a cushion, the closing action being entirely free from hammering, and there being moreover no pressing of the bottom nipper down as in the case of the Heilmann, so that, as already explained, once it is set, there is no danger of its coming in contact with, while its position ensures that the fibres are well laid in, the comb needles. Again, a neglected roller lap cannot push down the plate into the needles. It will only raise the feed roller.

The feed roller revolves in bearings on the nipper frame and rests on the bottom nipper plate, the lap being passed between it and the plate. The roller is spring weighted and can be adjusted relatively to the nip of the nipper, but, being once adjusted, is fixed in position. By means of a lever and ratchet feed arrangement, the forward oscillation of the nipper frame is

caused to give the desired amount of feed, the quantity being regulated by the simple adjustment of a pin.

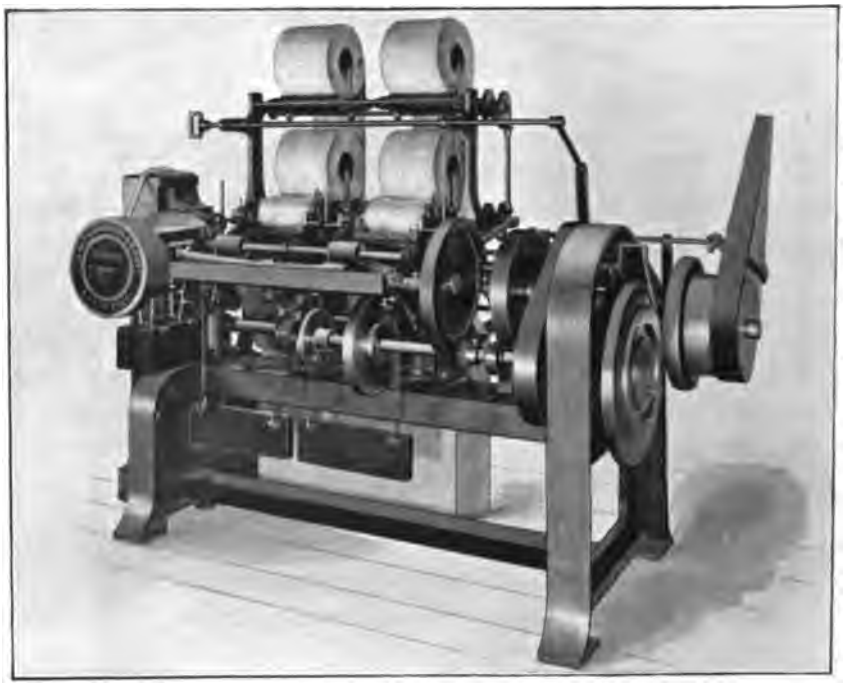
The top comb frame is also hinged to the nipper frame and receives normally a downward pull from a light spring. The end of the frame carries a small runner (capable of adjustment) which rests against the surface of a specially shaped and adjustable bracket. As the nipper frame oscillates, the bowl travels along the surface of the bracket and thus controls the rise and fall of the comb. In addition to the extent of the movement of the comb, the period at, depth to, and direction in, which it penetrates the lap are severally fixed by the shape and adjustment of the bracket. It is one of the chief features of this arrangement that the top comb enters the lap at a point as far forward as possible so as to be well in front of the uncombed portion, while as it penetrates further, it gradually approaches the face of the nipper and lies close up to the latter during the period of attachment.

Before passing on to notice the remainder of the operation it will be as well to point out that the feed roller, the nipper, and the top comb are all oscillated to and fro together, and that they are severally operated entirely as a consequence of this movement without the intervention of cams or similar means.

The operation of detaching the tuft of cotton from the lap and attaching it to the previously combed material is one of the most interesting in the Heilmann process. After the needles in the cylinder of the Heilmann machine have passed through the end of the lap, the projecting fibres are sustained by the fluted segment and the top leather roller is dropped on to the segment. Previously to this the detaching roller has been turned back in order to provide for the necessary overlap, and a little before the fibres are seized by the leather roller it commences to turn forward again in order to carry the new tuft forward and attach it to the sliver. There are one or two points in connection with this operation which require explanation. The first is that the tuft of cotton removed is confined to those fibres only which are gripped by the leather roller and fluted segment at the in-

stant of contact, and the work of detachment and separation is performed solely by these two parts without any assistance from the motion of the nipper. The second point is, that the detaching roller must be running at the full surface speed of the cylinder before it is allowed to touch the segment, and in consequence of this the grip is sudden and there is a snatching action on the fibres as they are drawn out of the lap through the top comb, which very effectively limits the weight of a lap workable on a Heilmann machine. Owing to the necessity of getting the leather detaching roller up to speed before contact with the fluted segment, it is found that at least a quarter of an inch of the sliver backed off is wound back again before the roller seizes the nipper tuft, so that all this length is lost for piecing, and it is this fact which renders the treatment of short cotton difficult on a Heilmann machine.

In the Nasmith machine this mechanism is altered. As was pointed out, the fluted segment is abolished, and there is therefore no need for the leather roller to be dropped on it, an operation which is very destructive to the covering of Heilmann rollers. Instead of three rollers there are now only two used for piecing and the work of detachment or separation is principally thrown upon the nipper. The detaching roller (to retain its name) receives a backward and forward rotation as before, but it is caused to stop and start more gently, never attaining the speed of the Heilmann roller although turning a much greater distance each stroke. The top or leather roller is mounted on the detaching roller and simply rolls upon it backward and forward, being in its most backward position just before piecing begins and in its most forward position near its completion. The method of communicating this rolling motion consists of coupling the lever, in which the leather roller is borne, to the nipper shaft, so that the reciprocal movement of the nipper is synchronous with the reciprocal rolling motion of the leather roller, the relative extent of the latter being regulated very simply. The leather roller of course receives, by friction with the detaching roller, a reciprocal axial rotation of



the usual kind in order to turn back the combed sliver preparatory to piecing, and then deliver the newly drawn tuft. Behind the detaching roller a second pair of rollers are placed which merely act as straighteners and pass the combed web forward to the usual calender rollers and draw box. The speed of the second pair of rollers is regulated by that of the detaching roller, to which they are geared.

The feature which forms the most radical change on the Heilmann procedure is the close relationship which now exists between the operation of the nipper and that of the detaching roller. As was pointed out, the Heilmann nipper, as a whole, has no movement except a slight oscillation through a short, almost vertical, arc, and the detachment of the tuft of cotton is controlled by mechanism having no connection with the nipper

which is stationary and inoperative during the piecing and separation periods. In the Nasmith machine the nipper and detaching mechanism are connected so as to operate synchronously, although the detaching roller proper is still given its backward and forward rotation. The oscillation of the nipper frame from the cylinder shaft controls, as has been pointed out, nearly every other motion, and this with the minimum of effort. Assuming that the nipper is moving towards its most rearward position, the first few needles of the comb and passing through the end of the lap and while this is still going on the direction of the motion of the nipper is reversed and it begins to travel with the needles but at a slower pace. The effect is that the finer needles comb out the end with less exertion and less strain on the fibres which are not so liable to be damaged. After the needles have passed, the nipper continues to advance and the smooth filling up piece on the cylinder sustains the fibres and keeps them horizontal. While the recession of the nipper is taking place, the connection between it and the leather roller causes the latter to move backward (in the direction of the nipper) on the detaching roller. The result is that the tips of the fibres in the head are early seized by the nip of the two rollers.

It is at this point that the chief difference in the action of the new machine as compared with the Heilmann is found and it is upon this that its effectiveness depends. As was shown, when the combed fibres are seized by the leather roller and fluted segment of the Heilmann machine, the nipper is stationery and the tuft is drawn out of the lap by their rotation, the length of the tuft and the amount of overlap being entirely limited. The result is that only a lap of comparative lightness can be used, as, if its mass is too great, the power possibly obtained from the nip of the two parts is not sufficient to pull a thick tuft suddenly through the top comb, and, if extra weights were added, then would deflect the roller and damage the comb as well. In the Nasmith machine, after the fibres are seized by the detaching rollers, the nipper and top comb continue to advance towards the nip of the detaching rollers, and, at the

same time, the leather roller rolls forward on the detaching roller, which also makes its axial rotation to effect the piecing. The result is, that instead of only gripping those fibres in the lap head that are actually under the Heilmann roller at the moment of contact with the segment, a much greater number are successively seized and gradually drawn through the top comb, to an extent depending upon the amount of forward movement of the nipper, a longer tuft being thus extracted. In addition to this, the overlap is a much longer one and is better made. As a consequence of the successive seizure of fibres thus obtained, a lap of greater substance is easily combed, one double the ordinary weight per yard being handled with perfect ease, because the tuft is not jerked instantly through the top comb, but gradually drawn through it to a much greater length, the period of the operation of the top comb being much increased. The length of material delivered to the detaching rollers is not merely that of the feed, but is that of the feed plus the forward movement of the nipper during the same period. As the path of the nipper during the operation is directly towards the detaching rollers the fibres are delivered in the very best way without any possible snatching or damage.

The top comb is put into the lap immediately before the fibres are gripped by the detaching roller. It is dropped in well in front of the nipper, and the result is, that, all the previously uncombed length of the tuft is drawn through it, as well as some of the combed part, and all the noil is held back by it. As the nipper, carrying with it the top comb, approaches the detaching rollers, the comb gradually moves nearer to the face of the nipper, which is thus allowed to approach the rollers very closely. The actual separation of the tuft is principally the work of the recession of the nipper (which is the exact opposite of the Heilmann method) and the result is that all the short fibre, nep, etc., is left behind the top comb, which, when it lifts, leaves them at the end of the lap to be removed by the passage of the comb needles. The separation of the tuft is accomplished before the nipper has made its full

backward movement and the end of the lap is presented to the needles of the cylinder while the nipper is still moving backward. The result is that all the waste is effectively removed at once.

A word or two may now be said about the simplicity of adjustment. It has already been pointed out that the nipper cannot be made to touch the needles when it has once been set to the gauge. The set screws at either end raise or lower the nipper on its frame, the pivots, unlike those of the Heilmann machine, being fixtures in the framing. The throw of the nipper is fixed by the crank, and, when at its most forward position, each nipper is set by its own screw to a given distance from the detaching roller. Once all have been set alike, they may be moved simultaneously nearer to or further from the roller. These two settings are entirely independent of each other, and the one may be changed without in any way affecting the other. The opening of the nipper is regulated by simply adjusting an incline and is also independent and unaffected by alterations in the other settings.

The setting of the top comb is extremely simple, whilst the setting of the leather detaching roller consists in making it parallel with the under roller and in line with its fellows, and when this is done in regulating them to a given distance from the nipper, which can be done by a single screw. Thus, instead of the delicate setting of the detaching roller necessary in the Heilmann, we have a setting not more difficult than that of a drawing head top roller. There are only two things to time, namely the detaching roller cam, which determines the moment when the rollers commence to turn and which is then a fixture, and the crank pin driving the nippers. Neither of these timings in any way alters the previous settings. Finally the quantity of waste made is determined not by an alteration of the combs, for theoretically these must always be set to take out the actual dirt, however low the percentage is, but by altering the distance of the nipper and top comb from the nip of the detaching roller, thus affecting, not the taking out of the dirt, but the length of

fibre taken out as waste. A single screw is provided to alter this and it is only a few seconds' work.

Although the machine is now past its experimental stage, there being a number at work, the writer does not care to make statements of its productive capacity until further experience has been gained. It may however be stated without the least spice of exaggeration that a production per head of at least double that of the Heilmann machine can be easily got and it is expected that a much larger quantity can be obtained. In a machine under the maker's care making 100 beats per minute, 200 pounds per head have been obtained in 50 hours. The lap was made of Egpytian cotton, was 10½ inches wide and weighed 32 pennyweights per yard, the waste extracted being 14 per cent. The machine is at work combing successfully American cotton of seven-eighths of an inch staple and the same machine with some small changes can be made to comb Sea Island cotton. It is claimed that alike for its strength and simplicity of construction, the ease of setting the various parts, its great adaptability, and its productive capacity, the machine is an advance upon any other yet put upon the market.

The PRESIDENT. Is there anything to be said on this paper? If not, we will proceed to the reading of the next paper, An Electrically Driven Cotton Mill, by Mr. JOHN O. DEWOLF.

*AN ELECTRICALLY DRIVEN COTTON MILL.

JOHN O. DEWOLF, Boston, Mass.

It is not my intention in this paper to describe in detail a cotton mill or the lay-out of its machinery, as the members of this Association are already familiar with such work. The subject of electrically driven cotton mills is also one that has been considered by you at previous meetings, but I still believe that you will be interested in a description of some of the special features of the Olympia Cotton Mills at Columbia, S. C., which is the largest application of this method of driving cotton mills that has been attempted.

The Olympia was designed by W. B. Smith Whaley & Co., the work of construction commenced in 1899, and the mill started in 1901. Its general lay-out comprises the main mill with the power plant back of and separate from it, except for a connecting passage way about 20 feet long.

The mill itself is 151 feet 2 inches wide by 553 feet 2 inches long, four stories high and without basement except under a small part at one side. The first floor is devoted to the opening machinery, part of the weaving, and cloth room; the second floor to warpers, slashers, spooling and the rest of the weaving; the third floor has the lappers, cards, drawing, and roving frames, and the entire top floor is devoted to ring spinning.

I will not go into the details of the machinery but will simply say that the lay-out provides for 104,000 spindles, 2,400 Draper looms and other machinery in proportion for making print cloths.

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* For further references on this subject see foot note on page 258.

FIGURE 1. OLYMPIA COTTON MILLS.

The accompanying illustrations show the mill in elevation and cross section, and give a good idea of its appearance and general construction. Each story is 18 feet high, and on the top story this height increases to about 21 feet at the center, owing to the pitch of the roof. The bays are 10 feet 8 inches and the span of the floor beams 24 feet. These beams are 12 inches by 17 inches, except those supporting the third floor, where two 6-inch by 12-inch timbers are bolted together. All of the columns are of wood, cylindrical in shape, those on the first floor being 12 inches in diameter, on the second floor 11 inches, on the third 10½ inches, and on the fourth floor 10 inches. Southern pine is used for all floor timbers and columns.

At the basement and first story the walls are 45 inches thick and these decrease to 39 inches at the second story, 34½ inches at the third, and 25 inches thick at the top. At suitable intervals the pilasters are built larger and contain ducts for the heating and ventilating system, which will be referred to later. The windows are 7 feet 2 inches wide by 13 feet 6 inches high, with a mullion through the centre, each window having two transoms, which are glazed with ribbed glass, although plain glass is used in the window sashes.

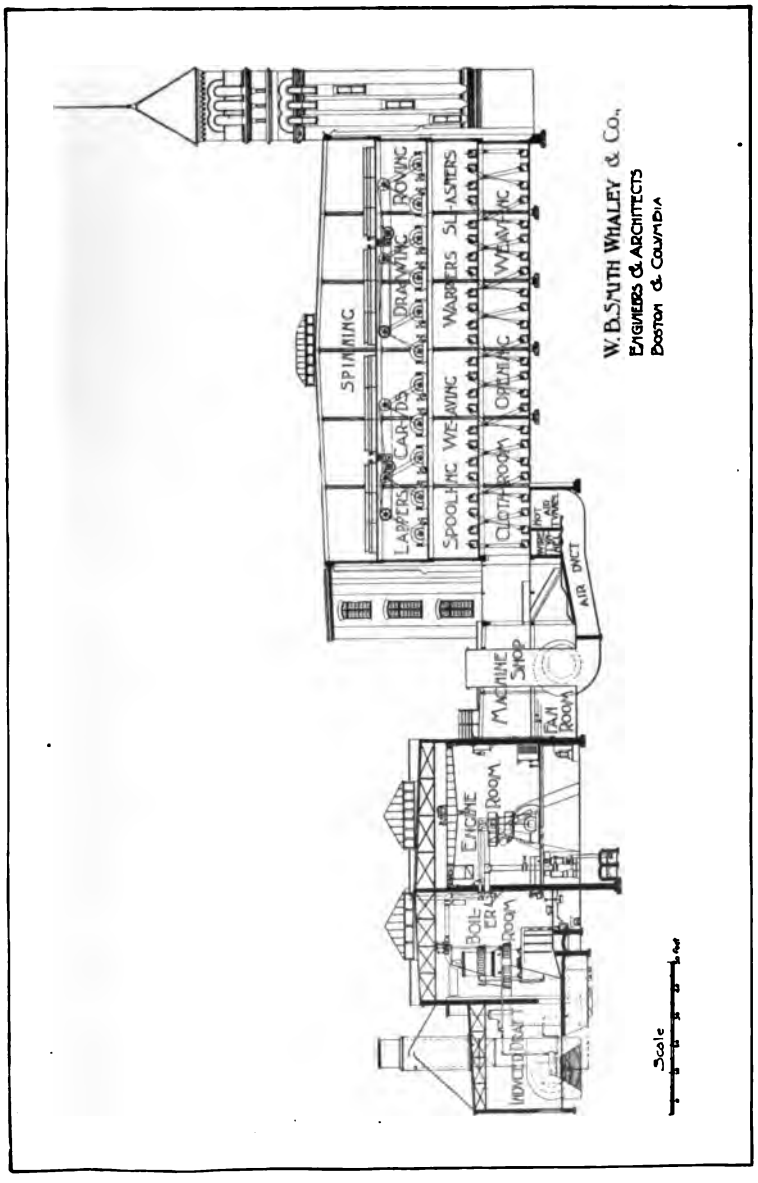
W. B. SMITH WHALEY & Co.
ENGINEERS & ARCHITECTS
BOSTON & COLUMBIA
SPINNING
CARDS
DRAWING
ROVING
SPOOLING
WEAVING
WARPERS
SLASHERS
CLOTH ROOM
OPENING
AIR DUCT
MACHINE SHOP
FAN ROOM
ENGINE
BOILER
Scale

FIGURE 2.

The picker room on the first floor is separated from the rest of the mill by a fire-proof partition built of 3-inch steel channels set 12 inches on centres and covered each side with metal lathings, the space between being filled solid with concrete, and both surfaces plastered. Around the elevator well and toilet rooms in the rear towers, the same style of fire-proof partitions are used, except that 2-inch channels are used instead of 3–inch.

All the floors are of three thicknesses, the lower or main floor being 4-inch plank dressed to 3¾ inches and grooved and splined; on top of this is a layer of felt, and the intermediate floor of ⅞-inch boards, on top of which is another layer of felt, and then the top floor of ⅞-inch stock. The roof planking is 3 inches, dressed to 2¾ inches, carried on 10-inch by 14-inch timbers pitching ½-inch per foot, and the roofing consists of 5-ply asphalt felt covered with asphalt and concrete screenings. With the exeception of the top floor, which is of maple, all of the flooring, roof planking and roof timbers are of Southern pine.

The towers on the front of the mill contain the stairways and tanks for fire protection. There is also a clock in one and a bell in the other. Besides these there are two towers which adjoin the rear of the mill and are of the same height as the mill itself. Each of the latter contains an electric elevator and two toilet rooms, so arranged that the elevator is between the entrances to the toilet rooms. An open *well* is left for the water and sewer piping.

For heating and ventilating this mill a forced circulation of air is used similar to the Sturtevant system but having some modifications that seem desirable in a mill of this size. The blowing apparatus is located in the basement under the machine shop about 30 feet distant from the main mill, and consists of two Sturtevant steel plate fans, having wheels 14 feet in diameter by 7 feet wide. Each fan is driven by a 11½-inch by 16-inch horizontal direct connected engine, and the discharge

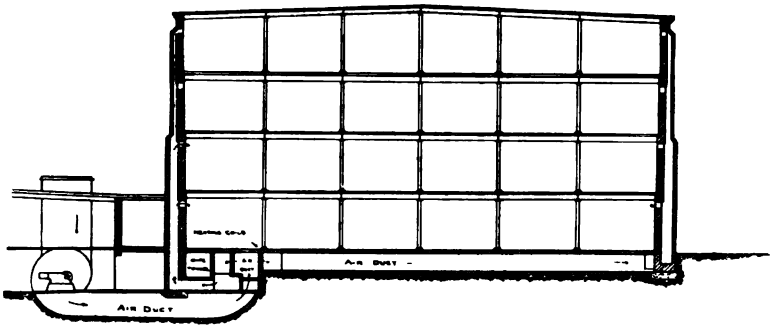

FIGURE 3. SECTION SHOWING HEATING FLUES.

is downward and horizontal into brick ducts running under ground and discharging into the air tunnel.

The main air tunnel, running nearly the entire length of the mill, directly supplies air to the flues on one side of the mill; the supply for the other side being through four branch tunnels leading from the main air tunnel, as shown in the accompanying plan. Each of these is 4 feet by 6 feet and supplies air to three sets of vertical flues. The air supply to the different floors is through 24 flues, 12 on a side, built in the pilasters of the mill, each being 43 inches by 25 inches at the bottom, diminishing to 35 by 25 inches at the next story, 21 by 25 at the third and 13 by 25 inches at the top story. The dampers in the walls are 16 inches square, except on the top story where they are 16 by 20 inches.

The air is heated by a series of heater sections which heat it just as it leaves the main air tunnel instead of at the fans in the usual manner. This, we believe, is not only a more economical method of heating the air, but gives a more perfect control of the temperature at the different parts of the room, especially where the mill is as large as this one, as the heat can be regulated independently of the volume of air without impairing the ventilating.

Each floor is equipped with moistening apparatus, there being 300 of the American Moistening Company's Humidifiers throughout the mill.

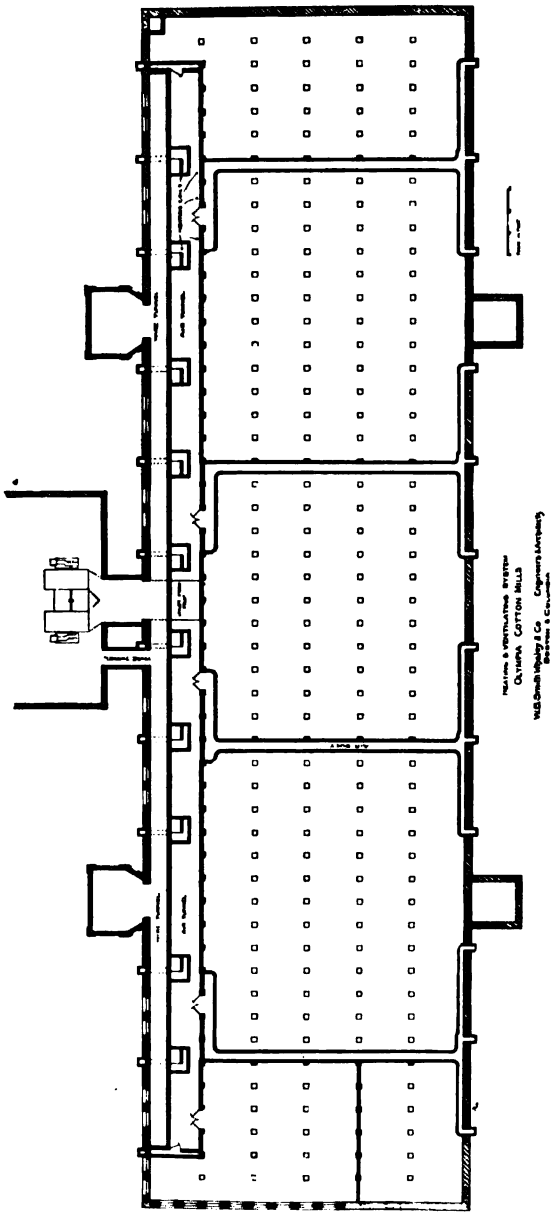

FIG. 4. PLAN SHOWING HEATING FLUES.

Before taking up the methods of electrical transmission and driving, it will be more logical to consider the source of the power and note the arrangement of the power plant.

In brief, this is a steam electric plant, twelve 250 horse power boilers furnishing steam to three cross compound condensing engines, directly connected to alternating current generators.

FIGURE 5. POWER HOUSE.

The general dimensions of the plant are 137 feet long by 120 feet wide, except at the boiler room, where it is 140 feet wide, and in addition there is an induced draft room about 39 feet by 37 feet adjoining the rear of the boiler room. Outwardly it presents the appearance of a two-story brick building, as the engine and boiler rooms both have two rows of windows. The roofs of those two rooms are the same height and nearly flat, pitching about half an inch to the foot, and have brick parapets along the ends, the top of which is at a height between the

third and fourth floors of the mill. That portion of the building nearest the mill is devoted to the machine shop and has its roof much lower than the other, being about level with the second floor of the mill and of the same height as that of the passage connecting the mill and power plant. There are basements underneath the machine shop, engine and boiler rooms.

The power plant is of fire-proof construction, the walls are of brick, the floor of brick and concrete carried by steel beams, and the roof trusses of steel, no wood being used except in connection with the doors and windows and the roof planking. On account of the electrical machinery, which would be injured by water, there are no automatic sprinklers in the power plant, its fire-proof construction rendering them unnecessary.

In the boiler room are twelve water tube boilers of the Cahall vertical type, 250 horse power each, set in two batteries of six each and run at a working pressure of 175 pounds. The smoke

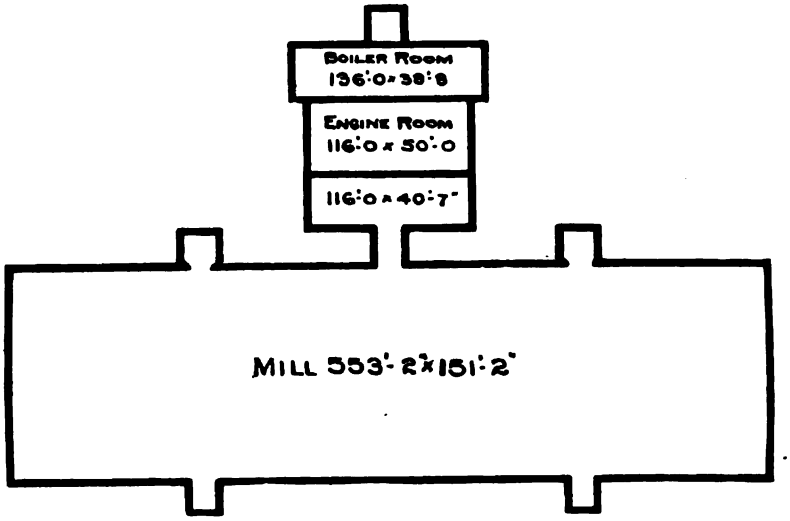

FIGURE 6. OUTLINE PLAN, OLYMPIA COTTON MILLS.

flues lead horizontally back from the tops of the boilers into vertical brick flues forming pilasters in the rear wall of the boiler house and connected at their lower ends with the main

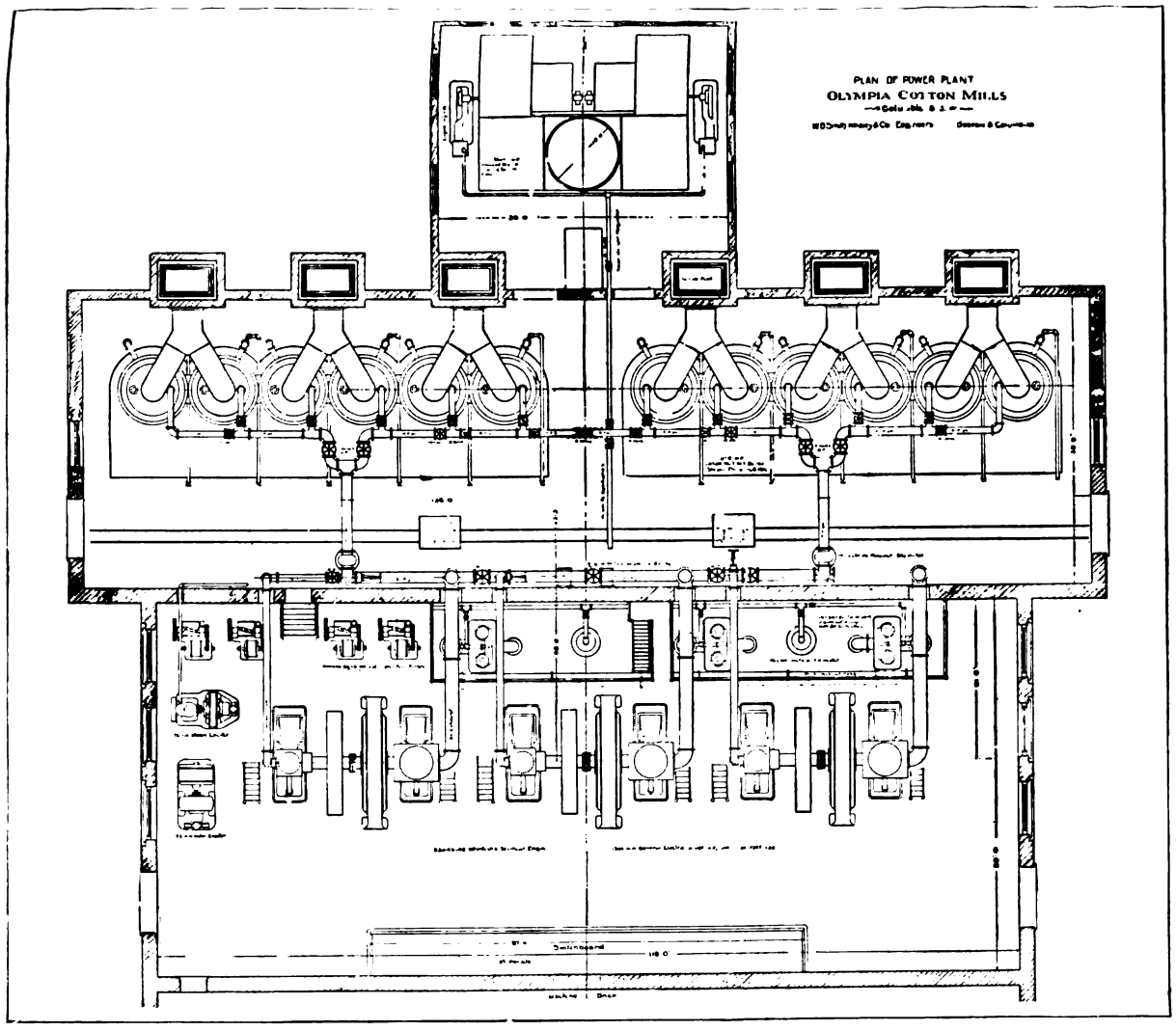

FIGURE 7.

smoke flue, which is a brick arched tunnel directly underneath the boilers and running nearly the whole length of the boiler house. The basement of 10 feet allows the construction of this tunnel and also the removal of ashes. Underneath each furnace is a hopper-shaped ash pit which discharges through a chute into ash cars that run the length of the basement.

At the center of the boiler house a branch from the main smoke tunnel runs back under the rear wall and into the induced draft room where it connects with the inlet to two Sturtevant steel plate exhaust fans, which produce the necessary induced draft. Each of these fans has wheels 14 feet by 7 feet, is of the "three-quarter housed" pattern with up-blast discharge, and is driven by a 11½ by 16-inch horizontal Sturtevant engine running at a slow speed to give the greatest economy in the moving of the hot flue gases. Both fans discharge through a Y-shaped connection into one stack 10 feet in diameter and about 35 feet high, the top being a little below the level of the mill roof, but on account of its distance from the mill the smoke and gases rise and give no trouble by blowing into the mill windows.

Adjoining the boiler room and connected with it by a few steps, as its floor is four feet higher than that of the boiler room, is the engine room containing three McIntosh & Seymour vertical cross-compound engines running at 133 revolutions per minute. The cylinders are 23 and 48 inches in diameter by 42-inch stroke, are steam jacketed, and have a reheating receiver between them. There are 60,000 pounds of metal in each fly wheel and its diameter is 14 feet.

These engines are especially designed for running in multiple, having McIntosh & Seymour's patent electrical speed changing device, which consists of a small electric motor revolving with the governor and acting on the governor springs through weights which it moves either in or out from the shaft, thus varying the speed four or five revolutions per minute either way. A small switch on the switchboard controls this, and by it the speed when starting is brought to the exact point necessary to synchronize the generators. This device is also used for giving

FIGURE 8. ENGINE ROOM.

an even distribution of the power among the different engines when several are running in multiple.

The condensing apparatus is located in the basement back of the engines, and consists of three 14 and 28-inch by 21-inch Knowles simplex twin vertical beam air pumps and jet condensers. These are of such size and so connected that any one may be shut down without interfering with the working of the engines. The feed water heaters are also in the basement near the condensers.

In the engine room back of the engines are four 6½ by 8-inch motor driven Knowles vertical triplex pumps for boiler feeding and also for supplying the water for the moistening system throughout the mill. In addition to these pumps there are two 8 by 6 by 12-inch vertical duplex Admiralty pattern steam pumps in the boiler room connected to the same system of piping.

The generating part of the power plant consists of three 1,300-kilowatt direct connected General Electric generators, each with 36 poles, running at 133 revolutions per minute and delivering alternating current at 600 volts. The steam exciter set, used for starting, or in event of injury to the motor exciter set, is a General Electric marine type vertical engine direct connected to a 75-kilowatt direct current generator; this also could be used at night on the incandescent lights if the main generator should be out of service. There is also a 75-kilowatt direct current generator driven by an induction motor running at 600 revolutions, which is the exciter set ordinarily in use.

Directly in front of the engines and generators and reaching about half the length of the room, is the switchboard of blue Vermont marble, 57 feet 4 inches long and divided into 21 panels. These are arranged as follows: three panels controlling current furnished to outside parties, one outside output panel, two transformer panels, two exciter panels, three generator

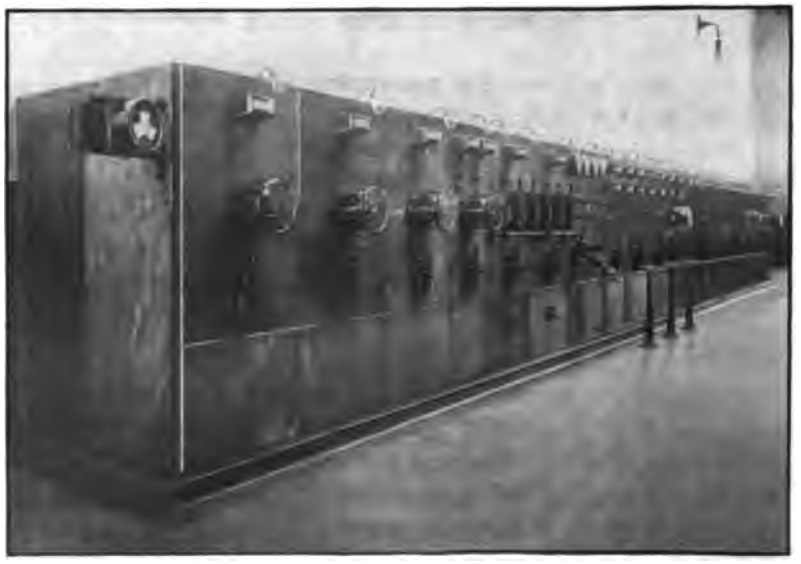

FIGURE 9. SWITCHBOARD.

panels, a totalizing output panel, eight 3-circuit motor panels and a 2-circuit lighting panel.

The transmission and distribution of power about the mill involves some features that I believe deserve more than passing notice.

After leaving the switchboard the wires pass across the machine shop basement to the wire tunnel leading from the power plant to the mill. The rest of the way they run in separate tunnels or ducts built for them, in which they are safely out of the way and protected from any accidental injury.

The wire tunnel from the power plant is 7 feet 2 inches wide and 9 feet 3 inches high, with arched roof, and the wires are carried on four sets of 4 by 6-inch wooden beams built into the walls. This connects with the main wire tunnel, which runs nearly the whole length of the mill next to the outer wall, and is shown on the plan of the heating and ventilating flues. This latter tunnel is 8 feet 6 inches wide, 10 feet high, and of fireproof construction. The wires are all run along the top of it and are supported on beams at convenient intervals.

From this tunnel the wires run to the different floors through vertical ducts 8 inches wide by 4 inches deep left in the brick wall. These ducts are covered by boards screwed in front of them, which give ready access to the wires when occasion requires, and yet securely protect them. Most of these ducts contain six wires and feed two motors.

Leaving the duct at the floor below that on which the motor is located, the wires run along the ceiling to the post nearest the motor, where they pass through the floor and up along the column, through the switch to the motor.

The method of supporting the motors and the wiring to them is shown by a photograph, and is the standard adopted not only in the Olympia, but also in the other mills designed by the same engineers. At the bays in which the motors are located the ordinary wooden beams are omitted and in place of them are steel channels of about the same depth, which not only carry the floor but also furnish a support for the motors which

is stiff enough to be free from the deflections or settling that is liable to occur if wooden beams are used. Between these channels, and rivetted to them, are two pairs of 10-inch channels about 5 inches below the floor and from them the motors are directly suspended.

With the exception of the slasher motor, which is on the ceiling of the second floor, the motors and shafting are all on the first and third stories, and the machinery on the second and fourth floors is driven from below. Power is furnished by 24 motors of which 20 are 150 horse power each and the other four are 30 horse power. These are all General Electric, 40-cycle. 3-phase, type L, induction motors, receiving current at 550 volts and running at 600 revolutions per minute under full load. The 30 horse power motors are used for driving the slashers, openers, cloth room, and machine shop.

The 10 spinning motors are directly coupled to the shafting through flexible couplings, similar to the ordinary jaw couplings, except that cylindrical pieces of rubber are interposed between the sides of the jaws, so that the pressure is transmitted through these pieces of rubber which can yield slightly. The lappers are also driven from shafting directly coupled to the motor and running at 600 revolutions per minute. The rest of the shafting is belted from the motors and runs at 300 revolutions per minute, with the exception of the slasher shafting; this has a speed of 350.

Each spinning motor drives about 120 feet of shafting and is located at the middle of the length, so that it drives about 60 feet in both directions. There are two lines of spinning shafting running the length of the mill, five motors in each length, each motor driving 38 spinning frames, with a little over 10,000 spindles. The motors driving the loom shafting operate longer lengths than any others, although in no case does the shaft extend more than a hundred feet from the motor. These motors have extended shafts and two pulleys at each end, so that each motor drives through four belts.

The shafting where it receives the power from the motors is 3

FIGURE 10. INDUCTION MOTOR.

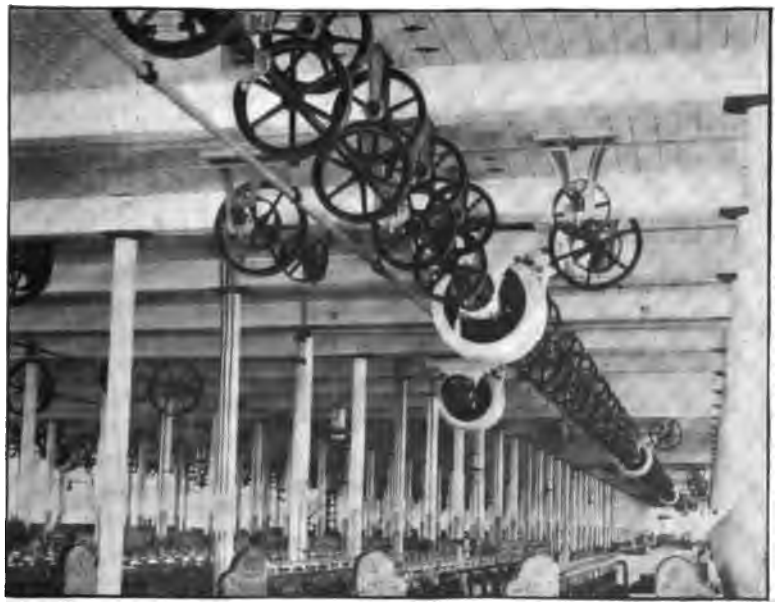

FIGURE 11. ARRANGEMENT OF MOTORS ON SHAFTING.

inches in diameter, but nearly all of the other shafts are $2\frac{11}{16}$ inches. This, it will be noted, is much smaller than can be used with the ordinary belt or rope driven layout, and gives a large saving in the shafting cost.

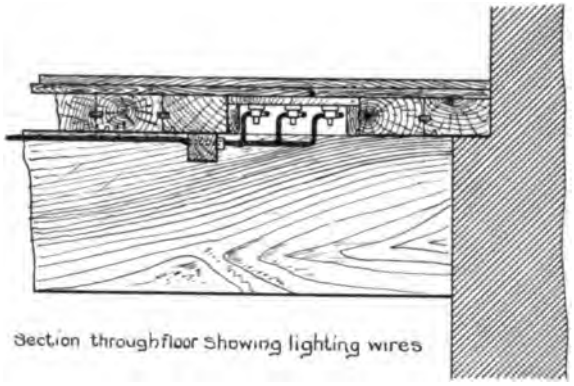

FIGURE 12.

One of the important features of the electric wiring of this mill, both for power and light, is that no holes are made in the floor timbers for the wires to pass through. In the case of the motor wires, they run parallel to the beams after leaving the ducts in the brick wall, and therefore no holes are required.

The method of running the electric lighting wires is shown by the accompanying cut. Instead of carrying them along the ceiling and through holes in the floor beams, as is frequently done, they are run above the beams in channels left for them in the underside of the flooring. Two of the floor planks are left out to form this channel, the two thicknesses of boards above giving the necessary strength, so that there is no weakening of the floor. This arrangement places the wires where they are more out of the way and better protected than they would be anywhere else, and saves not only the time usually required to bore holes in the beams, but also saves the strength of the timbers.

Without going at length into the tests that have been made I will give some of the general results showing what is going on

from the switchboard to the producing machines. Each of the motor circuits has its own indicating watt meter so that the current is readily measured.

Each spinning motor drives 38 frames of 10,032 spindles which run at 9,000 revolutions per minute. Tests on these motors give the following results while number 35 yarn was being spun:

No. of frames running,	38	28	18	8	0
Power in kilowatts,	140	107	76	44	17
Spindles per kilowatt,	81.2	83.8	82.5	78.2	—

This gives an average of about 82 spindles per kilowatt or 62 per horse power, and the mechanical and electrical losses between the switchboard and the producing machinery amount to about 12 per cent.

Four 150 horse power motors drive the weave room and show these results on Draper looms, running at 160 picks per minute:

No. of looms running,	633	549	465	381	297	213	129	45	0
Power in kilowatts,	154	136	120	103	89	74	60	43	32
Looms per kilowatt,	4.7	5.3	4.9	6.0	5.6	6.0	4.9	4.1	—
Looms per horse power,	3.5	3.9	3.7	4.5	4.2	4.5	3.7	3.1	—

The average is about 5.4 looms per kilowatt or 4.0 looms per horse power and the average mechanical and electrical losses between the switchboard and the looms amount to about 20 per cent.

Averaging all of the losses gives an average total loss of about 14 per cent. and even this will be found to be reduced in actual operation, as all of the motors are not taking their maximum at the same time. I will not go into the details of the tests made on the engines and generators, but will simply say that from a series of such tests it appears that the total average loss from the indicator cards to the producing machinery is about 17 per cent. and I believe even less.

In this article I have tried to explain the general design and construction of the Olympia Cotton Mills and have only referred briefly to the results that are being obtained there. Special

provision has been made, however, for testing all parts of the plant and I hope at some future meeting of this Association to present a paper on the results of tests made there.

The PRESIDENT. We have another paper on The Electric Drive for Cotton Mills, by Mr. W. B. SMITH WHALEY, of Columbia. S. C. We will have this paper now and take the discussion of the two papers at one time.

Mr. W. B. SMITH WHALEY. Gentlemen, I cannot add very much to what has been previously said by Mr. DEWOLF, as his paper covers mainly the features of the installation of the plant and the general makeup of the whole drive. The paper that I have prepared I will not read, because I presume it is short enough for most of the gentlemen here to look over and find out the points that I am trying to demonstrate as to the work that we have done on this line. The object of this second paper is simply to bring before you the results that have been obtained up to date. The number of mills installed and the range of the powers have been on such a satisfactory scale as to almost eliminate any doubt as to the possibility of either a large mill or a small mill reaching a point that we are seeking here to demonstrate, namely, the economy of the drive. The number of mills installed at the present time with the steam electric drive is eight or nine, and they range all the way from 600 horse power to 6,000 horse power. A great many of the plants previously installed rented their power, in other words, obtained their power from a source outside the mill, and the results could only be measured from the switchboard or receiving board in the mill to the work produced. In the cases of the mills alluded to above we would have the entire power measured from the indicator cards of the engine to the work produced.

There will be a paper presented before the American Society of Mechanical Engineers at their meeting in Boston next month, giving in detail all the tests that were made on this plant of the Olympia Cotton Mills. The whole matter sums up the fact that the electric drive, from all the data that we can get upon it, is unquestionably one of the most economical drives that we can possibly install in textile mills.

The question previously has been raised as to whether the textile mill, differing radically from shops and other classes of work using power, would not more nearly consume the total power at all times, and therefore leave very little margin for lost power as usually measured in shops and on other classes of work. But it is clearly shown from the case of the Olympia Cotton Mills that we have a saving of 43 per cent. in the friction of the mill. I do not care to go further into this phase of the subject today, as I think the paper before the American Society of Mechanical Engineers will explain it very fully and give all the tests that may be desired.

*THE ELECTRIC DRIVE FOR COTTON MILLS.

W. B. SMITH WHALEY, Columbia, S. C.

In the past decade numerous installations of the electric drive in cotton mills have been effected, and the propositions, as well as the advantages, of this method of operating have been repeatedly placed before the members of the Association by those directly operating the mills and by those engaged in equipping them. These different views have met with more or less comment. No satisfactory data in regard to the absolute comparison of results has as yet been placed before the Association.

The advocates both for and against this method of operating textile factories have brought forth, with considerable freedom in their various articles, the assumed advantages and disadvantages. The ability to investigate any power plant designed and

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* For further references on this subject see Transactions as follows:

Electrical Transmission of Power, ZACHARIAH ALLEN, Vol. 10, p. 31.

Electrical Tests in Cotton Mills, ANTHONY C. WHITE, Vol. 37, p. 38.

Application of Electro Motive Power to Mill Work, W. S. KELLEY, Vol. 46, p. 16.

Cost of Long Distance Electrical Power Transmission, W. S. KELLEY, Vol. 47, p. 85.

Electricity in Mill Work, O. S. HUSSEY, Vol. 50, p. 81.

Electrical Transmission of Power for Cotton Mills, C. J. H. WOODBURY, Vol. 53, p. 40.

Recent Developments in the Electrical Transmission of Power, C. J. H. WOODBURY, Vol. 54, p. 52.

Electrical Transmission of Power at the South, D. M. THOMPSON, Vol. 58, p. 89.

Operated by Electricity from a Distance, JOHN ECCLES, Vol. 58, p. 211.

Electrical Driving of Textile Establishments, SIDNEY B. PAINE, Vol. 58, p. 216.

Generation and Distribution of Electric Power for Manufacturing Purposes, C. A. STONE and E. S. WEBSTER, Vol. 58, p. 243.

operated especially on the lines projected for the best installation of this class of work has never before been presented.

The writer has been repeatedly called upon for his views in regard to the working of these plants, and could only give cursory data from the handling of a plant that was operated electrically, but was unable to point to the causes, otherwise than prospective, of the economies exhibited. We now have the good fortune to have installed and in operation so many of these plants that the speculative features can be measured with very little doubt.

New mills have been designed in the last six years with the most modern appliances, deriving their power from steam engines and distributing it by means of electricity. The distribution of the power for the purpose of operating the plant can be measured from the generating source, and the connecting link, the electric drive, can be definitely compared with the other methods of operating such plants by means of ropes or belts.

A few years ago I installed a plant driven by ropes and belts and also one driven by electricity. It had been the practice previously to adopt electricity in places where the convenience of the method was concerned rather than its possible economy. This gradually developed into its adoption as a sole means of

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Electricity for Mill Purposes, FRANK P. SHELDON, Vol. 62, p. 241.
Electrical Transmission of Power, E. B. RAYMOND, Vol. 64, p. 288.
Electrical Dynamometers, CALVERT TOWNLEY, Vol. 64, p. 292.
Auxiliary Power Plants with Electrical Transmission at Grosvenor Dale and Lyman Mills, FRANK P. SHELDON, Vol. 66, p. 298.
The Advantages of the Electric Driven Cotton Mill, W. B. SMITH WHALEY, Vol. 66, p. 315.
Fallacies Concerning the Electric Drive, SIDNEY B. PAINE, Vol. 66, p. 319.
Economy of Electric Drive, W. B. SMITH WHALEY, Vol. 66, p. 335.
Measurement of Electric Power, SIDNEY B. PAINE, Vol. 66, p. 341.
Electric Motors in Storehouses, E. W. THOMAS, Vol. 66, p. 344.
Description of the Electric Power Transmission Plant at Valleyfield, J. J. ASHWORTH, Vol. 67, p. 221.
Electric Transmission of Power in Machine Shops, H. G. McKerrow, Vol. 70, p. 148.
The Plant of the Niagara Falls Power Company, P. P. BARTON, Vol. 71, p. 182.

driving, because it was more convenient on account of the location of the plant in the development of water power, to distribute the power electrically, rather than from the fact that it was possible to place it in any plant in competition with the older methods of driving.

In a range of mills from 600-horse power to one of 6,000-horse power that have been installed in the last three years, there has been a development of features and advantages directly comparable with the older methods.

A few years ago I presented before the American Society of Mechanical Engineers a paper on the relative advantages of the electric and rope driven mills. In one case the power was measured from the indicator cards to the work produced; in the other it was measured at the receiving switchboard which distributes to the mill the power purchased from an outside source. The relative value of these two methods of operating a mill was 26 per cent. friction in the rope driven mill, against 17 per cent. of friction shown in the electric driven mill, from the switchboard to the work produced. The connecting link from switchboard to the cylinders was still to be determined.

In designing the Olympia Cotton Mills of Columbia, S. C., the established custom in regard to the method of operating cotton mills was disregarded. The power plant was designed without any regard to the mill except that the generators supplied the current the same as the outside sources furnished it to the mill, to which allusion has already been made.

The operation of this plant under these conditions for six months has enabled us to obtain figures and data that I believe more than justify the adoption of this method of operating a cotton mill, as the results have been most favorable. The different departments have been carefully and regularly measured and the missing data from the switchboard to the cylinders has also been obtained and proven to be most satisfactory. The relative figures in this plant show that the combined losses from the cylinder to the work produced in the mill are much less than

by the older methods of operation. Comparative figures would be as follows:

Rope driven mill,	26
Electric driven mill,	15

There appears to be a clear gain of eleven points in favor of the electric driven mill; measured in value of friction there is a net saving to the mill of 42.3 per cent. of its friction. In other words, the efficiency of the motive power in producing work is increased from 74 per cent. to 85½ per cent. These losses are going on all the time and amount to a considerable figure. A saving of this difference in any institution would mean a net dividend on its capital stock. It is safe to say that in many of the older mills the friction load varies all the way from 50 per cent. down, and the adoption of the electrical transmission in these plants would unquestionably remunerate the company far more than the revamping of almost any other part of the plant.

The system adapts itself readily to older designs of mills and can be installed at no prohibitive cost. The resultant economies would more than pay for the change in a very few years. The fact that the speeds are extremely uniform has been more than proved in actual practice, and the production of plants using this method of operating is increased four to five per cent. in the same number of hours run. These with other economies result in a very satisfactory gain over any other known method of operating factories, and it must be only a question of time when the older plants must change their driving mechanism in order to avail themselves of the greater economies which are to-day unquestionably demonstrated for the electric transmission.

The installation as compared with the rope or belt drive for mills exceeding 25,000 spindles is unquestionably as economical, if not more so, and in the Olympia it has proven itself much cheaper. The decreased cost of that installation is unquestionably many thousand dollars. The shafting and belting are one of the largest items of saving and have been cut in two, or even

reduced to 40 per cent. of the cost of shafting for the same distribution by a rope or belt drive.

These figures upon investigation must appeal to the investor, and the improvements constantly going on in this manner of operating cotton mills have reduced the cost until a very substantial gain is the acknowledged result.

The PRESIDENT. Gentlemen, we would like some discussion on these papers.

Mr. JOHN E. PREST. Mr. President, I would like to ask whether it is preferable to put in small motors of 20 or 30 horse power, distributing them in different parts of the mill, or to put in say three or four motors of 100 or 200 horse power. Whether 100 or 200 horse power motors would be more economical than small motors?

Mr. W. B. SMITH WHALEY. The large motors are more economical than the small ones, and the sub-division depends entirely on the nature of the work. For instance, we drive 48 spinning frames by a 150 horse power motor; about 10,000 spindles to the motor. You would not put in a 150 horse power motor and drive the full capacity on both carding and spinning. We sub-divide the work throughout the mill in the different departments, and put those motors in the departments in just as large units as possible.

Mr. JOHN E. PREST. Mr. President, one other question I would like to ask Mr. WHALEY. You have a mill fitted up with belt drive, and wishing to reduce the amount of friction that is lost by the belting, you put in a large dynamo; apply your power from your engine or wheel, whichever it may be, directly on the dynamo and distribute the power from that dynamo to

motors in the mill, dispensing with the large belts. Does the loss on the wires amount to as much as the loss on the belting? Is there a saving by dispensing with the belting and putting wires in and distributing your motors through the mill?

Mr. W. B. SMITH WHALEY. That depends entirely on the size of the mill.

Mr. JOHN E. PREST. Well, say a 30,000 spindle mill.

Mr. W. B. SMITH WHALEY. In a 30,000 spindle mill it would be more economical to install an electric drive than to install a rope or belted drive. In a 16,000 spindle mill it is slightly more expensive than the rope or belted drive.

Mr. ARTHUR H. GULLIVER. I would like to ask Mr. WHALEY whether in that subdivision of power it would be advisable in a room containing both spinning and carding machinery to have one motor for carding and another for spinning?

Mr. W. B. SMITH WHALEY. That has been our practice. We do not run any carding motors on spinning. We keep the carding separate, and also the looms. We run the departments by themselves as near as possible.

Mr. ARTHUR H. GULLIVER. One other question. What loss would there be if those motors should be installed so that a separate machine should be run with an individual motor? That is, for example, take a spinning frame; what would the loss be in putting in one motor per frame rather than one motor to 48 frames, as you suggested?

Mr. W. B. SMITH WHALEY. The loss would be, first, in the more expensive equipment, for first cost; and secondly, you can very readily see that in the stopping and starting of the frames from time to time, in the case of the motor that is driving one or two frames, the starting current or the peak of the load on the motor would be very much greater in the smaller

motors than it would be in a large motor. The starting power would be quite a factor in consuming the current. In a large motor driving 48 frames, the efficiency of the motor is reached at about 50 per cent. of its load, and the stopping or starting of one or two frames, or even a tenth of the frames, does not effect it. The extra current used in stopping and starting the frames is not felt by the motor, while with a small motor applied to a single frame, every time you stop and start the frame you would be using three or four times the amount of current usually taken by the motor in operating the frame.

Mr. ARTHUR H. GULLIVER. Is there any machinery in the cotton mill for which it would pay to install separate motors?

Mr. W. B. SMITH WHALEY. I don't know of any. I have not applied separate motors to any machines at present. I think there is a development now being investigated that may possibly in the future make it feasible to apply separate motors to spinning frames.

Mr. ARTHUR H. GULLIVER. That is what I referred to.

Mr. W. B. SMITH WHALEY. In that case it would be done by means of driving a direct current motor from the alternating current system, and instead of applying belts to the frames, applying motors to the frames and regulating the speed. Perhaps greater efficiency would be expected in that case than from the belted system. As yet we have not done anything like that.

The PRESIDENT. I would like to ask, Mr. WHALEY, if you have had any experience with or have considered at all the driving of individual spindles with motors.

Mr. W. B. SMITH WHALEY. I have not. I am not in favor at present, from what experience we have had, of isolating the work more than we have already done. We want to keep motors as large as we can, compatible with the convenient distribution and the loading of the floors.

Mr. JOHN E. PREST. I understand you to say that electrical transmission with secondary shafting, countershafting and all that — the combined cost of that would be less in large mills than the cost of a rope drive or belted drive?

Mr. W. B. SMITH WHALEY. Yes, the equipment would be less in mills of over 25,000 spindles.

Mr. JOHN E. PREST. And how about the wear and tear?

Mr. W. B. SMITH WHALEY. The wear and tear is much less.

Mr. JOHN E. PREST. I coincide somewhat, through experience that we have recently had in this matter, with Mr. WHALEY'S idea. We were recommended a while ago to install small motors on individual machines — for instance, put a single motor on a picker and run that picker independent, do away with your countershaft, have no countershaft at all, but stop and start your motor — that is all there is to it. We were told, "You are going to save a great deal of power; you will get rid of all your belts." We went so far as to order four or five motors put in, but after looking into it I said, "I guess you needn't send them." I made up my mind I would not put them on. We put on a 20 horse power motor to drive some spinning frames, a 40 to drive some looms, a 50 to drive some mules, distributing some 25 motors around, experimenting, on the recommendation of these electric experts, who said to us, "Get rid of your shafting; that is what takes the power; it does'nt take anything to drive the machine; it is the shafting that is the main point. Get rid of your shafting and your belts, and you save 40 per cent. of your power." We have been following their advice and we have paid dearly for it. I wish the small motors were out and the large ones in. I am taking out 30 horse power motors and putting in double the size, and I should advise putting in large motors, as Mr. WHALEY says, on the

same basis as the putting in of large engines, from the little experience we have had.

Mr. SIDNEY B. PAINE. The motor has been applied directly to the spinning frames and with extremely beneficial results. It is very limited, however, at present in its application. The motor, which is used almost universally in textile work is the induction motor, and on that motor you cannot economically vary the speed while it is running unless you use brushes on the motor or some device which consumes the current in the device instead of in the motor. Consequently, it has not been recommended to directly connect the motor to the spinning frames where it was desirable to vary the speed, and you can see that that would apply in a very small number of cases. But in those cases I think it is extremely desirable to apply the motor directly to the spinning frame. If you are running on one set of numbers all the time and do not desire to change the speed of your front roll, I think the directly connected motor will give you more production than the belted machines. So far as the efficiency is concerned, the efficiency of the large motor will be about 91 per cent. and of the small motor about 85 per cent. Taking into account the losses due to the use of shafting and belting with the larger motor, there is very little difference in the net efficiency between the small motor and the large motor in so far as the number of spindles to be operated from a given horse power is concerned. As Mr. WHALEY has indicated, there are experiments being carried on to devise a method of varying this speed where the motor is directly connected, and I am in hopes those experiments will be successful. I think that pickers can be driven successfully from the direct connected motor. The objection is that the motor will be on the beater shaft and take up space in the alley which is not often to be spared. Consequently I have never recommended the direct connected picker motor except in very special cases.

In regard to the subdivision of the motors, I think that Mr. WHALEY is entirely right in a new mill, where you can lay out your shafting and lay out your machinery to obtain the best

results by the use of the system. In some old mills it is not feasible. If your looms, for instance, run across the mill and the shafting crosses the mill, you cannot put in a large motor and omit many belts; and that is the condition that has held in some places where small motors have been recommended for driving the looms. On the mules I should put in just as large a motor as possible; that is to say, I should not subdivide any more than I could help in the mule room. We have made tests on some mules where we have installed a 150 horse power motor on approximately 15,000 spindles, spinning hosiery yarn, running about five stretches per minute. They were English mules, and the power varied on that motor from 75 to 275 horse power. We put on a small 20 horse power motor to find what it would do with a single mule, and the power varied from 2 to 25 horse power, showing the tremendous range in power demanded of a motor. And it is for that reason that I should recommend that you do not subdivide on your mules; that if you must have an individual motor on a mule, you must have a motor large enough for its maximum load. With a large motor in a mule room you can take advantage of the averaging, so that the efficiency would be greater. It would be much safer because the large motor would stand the excess load if the mules stroke at the same time.

I would like to speak for just a moment of Mr. WHALEY'S statement in regard to the number of mills operated by the electric drive. There are 12 new mills which have been designed for the electric drive where the motive power is to be furnished by steam engines. These have been designed by four different engineers. They aggregate over 20,000 horse power, and there are four old mills aggregating over 8,000 horse power where engines have been installed particularly for the purpose of driving generators to supplement power throughout the premises. I call attention particularly to the number of new mills which have adopted the steam electric drive. Of course I do not refer to mills like the Pierce Mills or some of these others where they have belted generators. They are all directly connected with the steam engine installed for the purpose.

Mr. WILLIAM L. LYALL. I would like to ask, does Mr. WHALEY mean to take these figures as the percentage of loss?

Mr. W. B. SMITH WHALEY. Which figures, Mr. LYALL?

Mr. WILLIAM L. LYALL. These 26 for rope driven and 15 for electric driven mills.

Mr. W. B. SMITH WHALEY. That is the percentage of friction on the rope driven mill.

Mr. WILLIAM L. LYALL. What would be the percentage of loss of the indicated horse power of the engine to the effective work done?

Mr. W. B. SMITH WHALEY. In the rope mill?

Mr. WILLIAM L. LYALL. In both.

Mr. W. B. SMITH WHALEY. Well, in the rope mill it is 26 per cent.

Mr. WILLIAM L. LYALL. That is from the indicated —

Mr. W. B. SMITH WHALEY. I have a list prepared some years ago, by Mr. CHARLES T. MAIN, I think, giving 30 odd different mills, and the average friction in the 30 odd mills was 25.9 per cent. In this case we got 26 per cent. in round numbers.

Mr. WILLIAM T. LYALL. That is, from the indicated horse power —

Mr. W. B. SMITH WHALEY. From the indicated horse power to the work produced.

Mr. WILLIAM L. LYALL. Well, now —

Mr. W. B. SMITH WHALEY. In the electric mill — go ahead.

Mr. WILLIAM L. LYALL. Just this point. First, you have the friction loss in your engine; next the loss in the generator of perhaps seven per cent.; then a loss in your wire.

Mr. W. B. SMITH WHALEY. No, nothing like that.

Mr. WILLIAM L. LYALL. Then you have a loss of nine per cent. on your motor?

Mr. W. B. SMITH WHALEY. Mr. LYALL, they don't figure that in practice.

Mr. WILLIAM L. LYALL. You get 91 per cent; the difference is nine per cent.

Mr. W. B. SMITH WHALEY. The actual run of the Olympia Cotton Mill gives twelve one-thousandths of one per cent. apparent losses from the engine and generator to the board, on an average of 60 tests. That is not the diminution of engine and generator loss, but there is a reflex action owing to the fly wheel effect of the armatures of the motors, passing in the mill from one to the other; they cannot speed up at all. Any tendency to speed is absorbed at once in passing the current back to the other motors, and there is an apparent reduction of the engine friction that reduces the indicator card apparent loss to the board to a very small fraction.

Mr. WILLIAM L. LYALL. That, you say, amounts to 12 per cent.

Mr. W. B. SMITH WHALEY. Twelve one-thousandths of one per cent on an average of 60 cards.

Mr. WILLIAM L. LYALL. It is 12 per cent?

Mr. W. B. SMITH WHALEY. Twelve one-thousandths of one per cent. In many cases it is minus. [Laughter.]

Mr. WILLIAM L. LYALL. You mean the friction loss, or rather the loss from heating —

Mr. W. B. SMITH WHALEY. The apparent reduction. I did not say it was a reduction of engine and generator friction at all; I said the apparent reduction. The only place we can measure it is on the indicator card; we cannot measure it anywhere else; and the difference between the current delivered by the instantaneous reading Wattmeter and the cards taken at the same moment show an apparent reduction of engine and generator friction, which is not the case.

Mr. WILLIAM L. LYALL. But supposing you test your engine and get a certain brake horse power, and then test, if you can, the horse power you get delivered by your motor?

Mr. W. B. SMITH WHALEY. I can give you a concrete case of that.

Mr. WILLIAM L. LYALL. What loss do you find there?

Mr. W. B. SMITH WHALEY. The engine and generator, with no load, you see, without any current — just turning, without current — have a loss by friction in the Olympia plant of 4.8 per cent.

Mr. WILLIAM L. LYALL. I know, but you cannot take that as a fair thing, because when the full load is on you are losing in heat, aren't you, with the current passing through the wires?

Mr. W. B. SMITH WHALEY. When the system is working that reduces the loss to less than 3½ per cent. as a maximum and it fluctuates all the way from 3½ per cent. or 2.91 per cent. to an apparent minus figure of 2.78 in an average of 60 cards. Now that is no reduction of that 4.8 per cent. as far as the engine is concerned, no reduction in it at all; but the fly wheel effect of the motors in the mill pumping back current when you

tend to accelerate, as they cannot get out of step, puts current into the line that the engine does not have to deliver from the indicator cards.

Mr. WILLIAM L. LYALL. I cannot understand how you can carry your current without loss, through both your wire and your machine.

Mr. W. B. SMITH WHALEY. Take a rope driven mill; the effect of acceleration is absorbed in the increased speed. Any acceleration at all, any tendency to accelerate, must necessarily speed up the machinery. In a direct current driven mill the same thing would occur, because there is no step in the machine.

Mr. WILLIAM L. LYALL. I know this, Mr. WHALEY, but you generate a certain amount of heat when you are working, which passes off and is dissipated in the air, both in the wire and in your motors. That means a loss.

Mr. W. B. SMITH WHALEY. There is very little heat dissipated in a properly designed wire. We design our wires for a 1½ per cent. drop.

Mr. WILLIAM L. LYALL. Your design is right I suppose for pretty nearly full load. You have got considerable heat there then.

Mr. W. B. SMITH WHALEY. In what?

Mr. WILLIAM L. LYALL. In your field pieces and the bearings of them.

Mr. W. B. SMITH WHALEY. Very little.

Mr. WILLIAM L. LYALL. It all takes power.

Mr. W. B. SMITH WHALEY. Very little; very little heat in that; practically none in the wires or connections; not sensible to the touch.

Mr. WILLIAM L. LYALL. Would you say, then, that this 15 per cent. represents all the losses?

Mr. W. B. SMITH WHALEY. Yes, 15 per cent. represents all the losses from the indicator card to the work produced. In spinning it is 12.1 per cent. on the spinning motors, and we have it for every motor in the mill — repeated tests.

Mr. WILLIAM L. LYALL. You have all the secondary shafting?

Mr. W. B. SMITH WHALEY. Yes, but that takes very little power; it is the loom counters that absorb the power.

Mr. WILLIAM L. LYALL. Those you have.

Mr. W. B. SMITH WHALEY. Very few. The spinning has none. The spinning takes nine kilowatts.

Mr. WILLIAM L. LYALL. I know, but the conditions are practically the same as they would be in the ordinary rope driven mill, except for the main shafting, as I understand.

Mr. W. B. SMITH WHALEY. The spinning took nine kilowatts out of 156 to turn the shaft without belts. When we put the belts on the loose pulleys it took 17 kilowatts. There was 120 feet of shafting coupled on to the motor.

Mr. WILLIAM L. LYALL. I guess you have got pretty near perpetual motion down there, so far as your electric drive is concerned. [Laughter.]

Mr. W. B. SMITH WHALEY. It takes very little power to turn the shafting.

Mr. JOHN E. PREST. Supposing you had a generator and a water wheel or a steam engine half a mile away from the plant, how much power would you lose on the wire in carrying it that distance to your mill?

Mr. W. B. SMITH WHALEY. It depends entirely on how much money you want to put into the transformers and the copper.

Mr. JOHN E. PREST. How much money?

Mr. W. B. SMITH WHALEY. How much investment you want to put into the lines carrying the current. You cannot reduce it.

Mr. JOHN E. PREST. Put in the best you can get.

Mr. W. B. SMITH WHALEY. How is that?

Mr. JOHN E. PREST. Put in the best you can get; how much power would you lose?

Mr. W. B. SMITH WHALEY. Well, I should think that our estimate for mill powers—I have made some small figures on that—that the ordinary price that a mill can get a power for is about the reasonable limit for the economical transmission of the current; that is, mills paying in the neighborhood of $15 for their current. Now in that distance the investment is simply measured by high voltage on small lines and transformers at each end, or a proportionately large line and low voltage. They are figures that you have to make for each individual case; they vary with the conditions.

Mr. JOHN E. PREST. What would be the average of that loss?

Mr. W. B. SMITH WHALEY. You can make it five per cent. if you want; it is simply a question of transformers and wire.

Mr. JOHN E. PREST. To carry half a mile, what size wire would you use? How large a wire would you put in? If it is more economical to put in small wire we want to use it. What is the most economical for carrying 500 horse power half a mile

and when you have carried it that distance what would be the loss?

Mr. W. B. SMITH WHALEY. I cannot tell you that off-hand. I have a concrete case—

Mr. JOHN E. PREST. Can you get 350 horse power out of 500 where you generate it and deliver it on your machines?

Mr. W. B. SMITH WHALEY. And carry it half a mile?

Mr. JOHN E. PREST. Yes.

Mr. W. B. SMITH WHALEY. O, I think so. I do not think there would be much trouble in that.

Mr. JOHN E. PREST. The reason for my inquiry is this: the Company with which I am connected contemplates building a new mill some time in the future. The site we have designed for it is half a mile from our present site. On our present site we have a water power which furnishes us about 450 horse power. We have also a small steam engine to help us in case of low water, but we are going to put in a larger engine which will give us about 1,000 horse power. Our plan has been to put in our power plant where our present mill is, and to transmit by electricity to our new mill. Now I would like to ask the question, Which would you consider the most economical, to put a steam engine at the new mill and transmit the power from the water plant, or to put the steam engine and the water wheels together at the old mill and carry the whole of the power to the new mill by electricity by wire?

Mr. W. B. SMITH WHALEY. Well, I expect a good many doctors will disagree on that. We would put all the power plant together, provided the coal was as convenient at that point as any other point.

Mr. SIDNEY B. PAINE. I would like to answer Mr. PREST'S question in regard to the losses. If you put in a wire with five per cent. drop, by investing twice as much in copper you will reduce the loss to approximately 2½ per cent. I presume that is what Mr. WHALEY meant when he answered Mr. PREST by saying that the loss depended on the amount of money he wanted to spend. The size of wire is not determined in any arbitrary way. We take the value of the power as given to us by the manufacturer, and we consider two conditions. If the power is expensive we must lose as little of it as possible and can afford to invest more in the larger wire. If the power is cheap, we can afford to lose most of it instead of investing so much in copper. In other words, there is a point where the interest and the care of the line will balance the loss of power, and it is not set at any arbitrary point. And also, of course, the loss in wire would depend upon the pressure with which you started, just as it would with any other way of transmitting energy — steam or water or gas or anything else: it would depend upon the pressure with which you start. If you start with 2,000 units of pressure — 2,000 volts — it will only take one-sixteenth of the copper that it would if you started with 500. And so there are several conditions that must be considered before you can determine the loss in transmitting power half a mile. If you use 2,000 volts to start with, you cannot at present use motors that will take less than 50 horse power. At the Manchester Mills, where the current is transmitted two miles from the central station, Mr. MCDUFFIE has been using 2,000-volt motors with no difficulty at all. If he had used 500-volt motors he would have had to put in transformers, in which case there would have been an additional loss of 2½ per cent.

The PRESIDENT. No further questions? We had one more paper for this morning's session, on Bleaching, which has been postponed until the fall meeting.

On account of the time which it will take to put in the electric lights and other apparatus to illustrate the paper on the Nernst

lamp, to be given this afternoon, we have cut this session a little short so as to give the electricians plenty of time during the noon hour.

NEW PROCESS OF SPINNING.

The PRESIDENT. Gentlemen, we have some samples of fine spinning that Mr. BROOKS has just brought in and which will be interesting to you.

Mr. CHRISTOPHER P. BROOKS. Mr. President and gentlemen, I have been requested by Mr. ROBERT BURGESS, the agent of the Grinnell Mills at New Bedford, or rather I ought to say now, the treasurer of the Slater Cotton Mills, to submit to the members of the Association several samples of cops spun on the ring frame. Mr. BURGESS has devised a means of doing away with the bobbins, using a tube, and these samples represent yarns from No. 48s to No. 100s. The advantages, of course, which Mr. BURGESS claims for this method are that the cops last longer in the shuttle. Mr. BURGESS himself will be here this afternoon and will be willing to give information to any members of the Association in regard to them. Mr. MERROW, who is now present, has seen this system in operation and will be willing also to give information. I have not seen it in operation myself; I have simply brought these samples up at the request of Mr. BURGESS for the information of any members who are interested in the spinning of cops on the ring frame. I will lay them on the table for examination.

The PRESIDENT. Perhaps it might be interesting to the members to hear from Mr. BURGESS, if he is in the room.

Mr. CHRISTOPHER P. BROOKS. He will not be here till this afternoon, but Mr. MERROW, I think, is here.

Mr. E. L. MERROW. Mr. President, I will say for the information of the members that I have seen this arrangement run-

ning at the Grinnell Mills in New Bedford. It is simply spinning from a tube on a small ring, doing away with a bobbin, and as Mr. BROOKS has just stated, the amount of time that this invention runs longer than a bobbin is as a rule somewhere about 11 minutes compared with 6½. It is exactly the same principle as is in use now, as I look at it; it is a small ring, using a traveller just the same as now, and I must say it surprised me very much to see it run. I have only seen one frame running.

The PRESIDENT. Any further questions? I think that finishes the business of the forenoon session, and I will declare a recess until 2 o'clock this afternoon.

FOURTH SESSION.

THURSDAY AFTERNOON, APRIL 24, 1902.

The Association met at Chipman Hall at 2 P. M., President FISH in the chair.

The PRESIDENT. We will now proceed to the presentation of the first paper of the afternoon, The Nernst Lamp in Industrial Establishments, by Mr. MURRAY C. BEEBE of Pittsburgh, Pa.

THE NERNST LAMP IN INDUSTRIAL ESTABLISHMENTS.

MURRAY C. BEEBE, Pittsburgh, Pa.

It is now some twenty years since the incandescent lamp was first put into commercial service. Since that time nothing radical has been done in the way of improving the efficiency of this device. It is true that their price has been materially reduced through the use of improved machinery and methods of manufacture, and, too, their life has been somewhat lengthened. The arc lamp has also undergone changes and improvements which have adapted it to use on circuits more rational than those of the old series arc machines. With the term "enclosed arc" we associate an improvement in arc lighting, in that the life of the carbons has been wonderfully increased by the use of an enclosing globe, which prevents the free circulation of air around the arc. Yet it may be said that improvements in methods of electrical illumination have not hitherto fairly kept pace with the great advances made by the electrical industries along almost any other line. Although engineers and scientists have realized for some time that existing methods of illumination are frightfully inefficient, it is only within a very few years that much has really been accomplished toward improving this condition of affairs. Both the present-day arc and the incandescent lamp leave much to be desired in the matter of illumination. How well that deficiency has been remedied by the Nernst lamp, may

be left to you, as interested critics, to judge after you have seen them in operation.

Dr. WALTER NERNST of Goettingen, Germany, was the first to utilize as an illuminant, the fact that certain of the refractory oxides of metals of the rare earths are conductors of electricity when hot. This important discovery was brought to the attention of Mr. WESTINGHOUSE, who was quick to recognize in it wonderful possibilities for improving existing methods of illumination. Since 1897, when Dr. NERNST first announced his discovery, the work of putting the new invention into commercial shape has been quietly but vigorously pushed to completion.

The nucleus or light giving element of the lamp has been termed the "glower." It is made by expressing from a die, a dough made up of the oxides mentioned, mixed with a suitable binding material. The porcelain-like string thus made is cut into lengths, roasted, and suitable terminals are attached. The finished glower in the standard 220 volt lamp is about .025 inches in diameter and about one inch long. They operate in the open air, which stamps them immediately, as something entirely different from the ordinary incandescent lamp filament you are used to. Further, they will withstand a much higher temperature than the carbon filament of the incandescent lamp, which accounts for the correspondingly greater efficiency, and the better color possessed by Nernst light, but of these I shall have more to say later on. Curiously enough, these glowers are insulators when cold, and hence require to be heated in some manner before they will conduct electricity sufficiently well to maintain themselves at a light-emitting temperature. The construction of a commercial and entirely automatic lamp then requires the addition of some heating device to provide for this initial heating. It was thought at first that the severe requirements imposed upon any heating device would effectually prevent the utilization of NERNST'S discovery in a practical lamp, but this has not proven to be the case. "Heaters" for this purpose are made by winding fine platinum wire upon thin

porcelain tubes. Platinum is quite capable of withstanding the intense heat in the vicinity of the glower and after all, its cost for this purpose is not great when it is considered that a large percentage of the platinum may be recovered from the worn out heaters. Referring to figure 1, two or more of these tubes are so placed that current from the line traverses the heater wire through the contact of the cut-out, thus heating them to a good white heat.

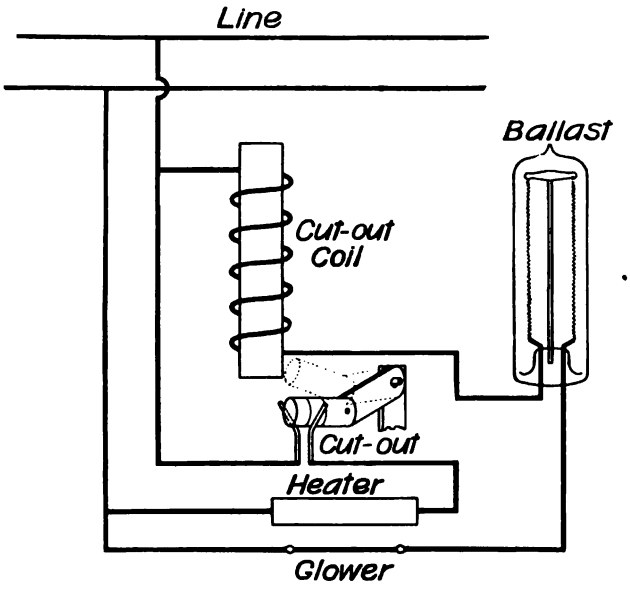

FIGURE 1. DIAGRAM OF A SINGLE GLOWER LAMP.

The proximity of the glower to the heater soon results in the glower becoming a conductor, and the current then passes through it also. When this has reached a pre-determined amount, an electro-magnet or "cut-out" coil has become strong enough by virtue of the glower current passing through it to attract the contact piece or armature of the cut-out, which, heretofore has closed the heater circuit. This disrupts the heater current, leaving only the glowers in operation, until the next

time the lamp is turned on. Ordinarily, about 30 seconds is the time required for starting. Opening the switch which controls the circuit allows the cut-out armature to drop into place again, thus connecting the heaters ready for operation. You already know that the glower becomes a better and better conductor as its temperature, or the current passing through it, is increased. This unstable condition of things would almost instantly result in broken glowers were not a steadying resistance placed in the circuit of each glower to choke down the current before it can reach an amount dangerous to that glower. This is accomplished by what has been termed a "ballast," the name signifying its function of holding down the current. Iron possesses

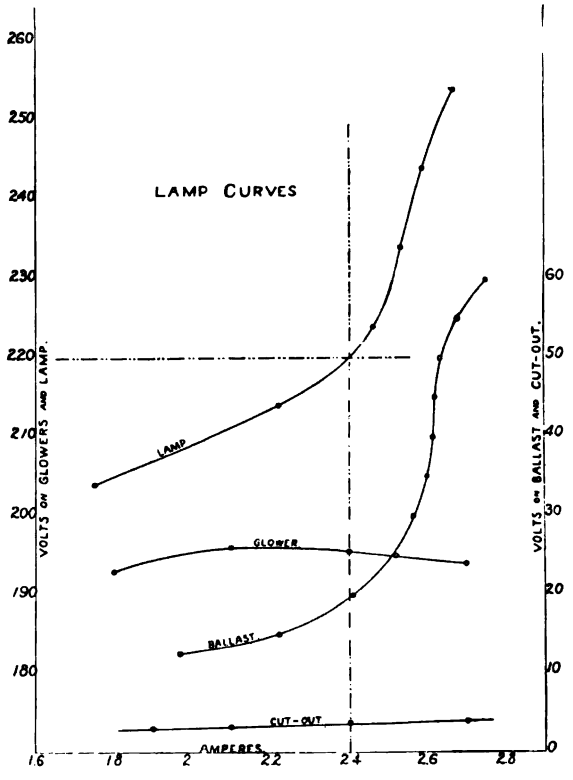

FIGURE 2.

exactly the opposite characteristic of the glower, in that its electrical conductivity diminishes with increase of temperature. This is true of all metals, but iron possesses it to a remarkable degree when at a dull red heat. All of this is expressed graphically in figure 2, in which the curve marked "glower" shows how a very slight increase in the voltage causes a very greath increase in the amount of current passing through the glower. The curve marked "ballast" in a similar way shows at a point marked 2.6 amperes, that a very great increase in voltage only slightly increases the current passing through it. When these two are combined, the resultant is the curve marked "lamp," which shows an operating condition much more stable with fluctuating voltage than that of the incandescent lamp. The size of the iron wire used in our standard ballast is exceedingly small, about .045 of a millimeter, or less than two one-thousandths of an inch, and this is somewhat smaller than a human hair. To prevent oxydation of this fine wire, it is enclosed in a

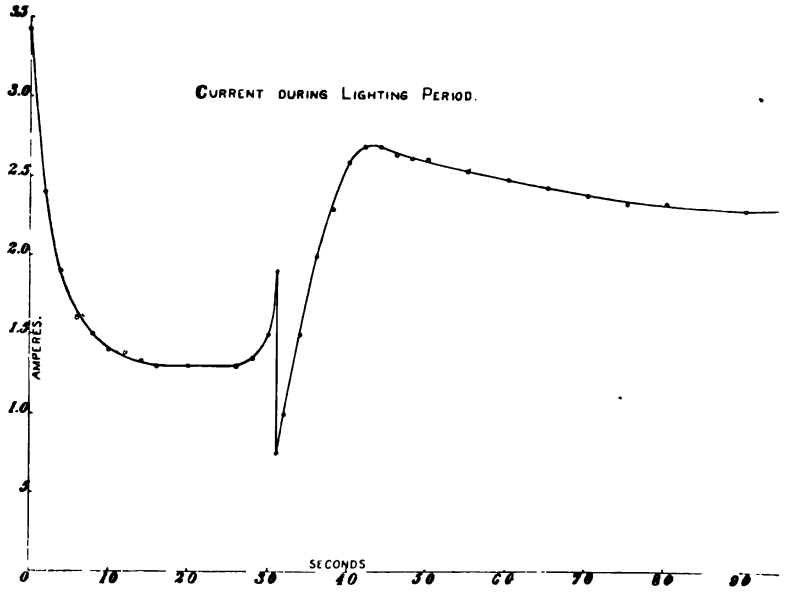

FIGURE 3.

small glass envelope, which is filled with an inert gas, the complete ballast resembling somewhat a miniature incandescent lamp.

Figure 3 expresses graphically what occurs from the moment of closing the switch controlling the lamp. The values indicated in the margin are typical of a 6-glower 500 Watt lamp which normally takes about 2.4 amperes of current. Until about thirty seconds have elapsed, the values of current are those taken by the heater after which the cut-out has thrown the heaters out of service, and the glowers reach their maximum after about forty seconds.

Lamps have been developed in the following sizes for operation on alternating current circuits only.

Although the lamp is adaptable to operation in any position, the present line of manufacture is directed toward lamps to be hung in a downward vertical position mainly because of the advantages possessed by a gravity cut-out.

Candle Power.	Voltage.	No. of Glowers.	Style.
50	110	1	Indoor.
50	110	1	Outdoor.
50	220	1	Indoor.
50	220	1	Outdoor.
100	220	2	Indoor.
170	220	3	Indoor.
400	220	6	Indoor.
400	220	6	Outdoor.
2000	220	30	Indoor.

The use of gravity rather than of springs or other devices in the cut-out has resulted in making this, the only moving mechanism in the lamp, a thoroughly reliable device.

The main features are alike in all lamps. The various sizes are made by assembling one, two, three, or six standard glowers with their requisite ballasts, etc. The replacement of perishable parts has been simplified by the use of aluminum plug contacts on glowers, heaters and ballasts, doing away with corroding contacts and troublesome screws. Convenience of making re-

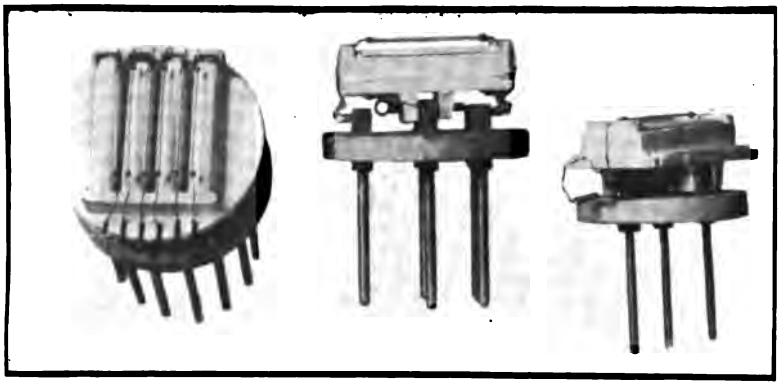

FIGURE 4. HOLDERS FOR SIX, THREE AND ONE GLOWER LAMPS.

newals is still further facilitated by having glowers and heaters mounted upon an easily removable piece called the "holder," which may be plugged into place very much as you are accustomed to replacing an incandescent lamp in its socket. In fact, the housing of the lamp which contains the ballasts and cut-out may be considered as a special Nernst lamp socket, and with a few spare holders in stock, the lamp inspector has only to pass from lamp to lamp, changing holders where necessary and then repairing the old ones at odd times, and where proper facilities are at hand. The lamps contain no combustible material whatever and all parts are assembled in a substantial manner. The six-glower 500 watt lamp is our largest unit, and is furnished with either sandblasted ball, eight inches in diameter, or a dome shade. The former is neat in appearance and is much used where a general or artistic illumination is required. For many purposes the dome shade is desirable for the reason that the light is directed downward, where it is needed for special illumination. In case the multiple glower lamp is used with a dome shade, an opalescent "heater case" is provided also, the purpose of which is to diffuse the light as well as to stagnate the heat, thus facilitating more rapid starting. The three-glower 250-watt lamp is a more suitable size in many cases. Especially where

FIGURE 5. HOW TO GRIP THE HOLDER WITHOUT DISTURBING GLOWERS.

ceilings are low, more units of less power are much to be preferred on account of the more even distribution of the illumination thus possible.

In general the 250-watt lamps spaced about fifteen feet apart give an effective general illumination. When ceilings are high enough, say over fifteen feet, 500-watt lamps spaced 20 to 22 feet between lamps is adequate for almost any purpose. For illuminating storage rooms and passageways and the like, of course fewer lamps will suffice.

Those of you who chanced to see the exhibit of 100 or more six-glower Nernst lamps in the electrical building of the Pan-American

FIGURE 6. SINGLE GLOWER LAMP.

Exposition must have been struck with the beauty of that illumination. They operated during the entire season with no trouble whatsoever beyond the occasional replacing of glowers and heaters. At the Westinghouse shops at East Pittsburgh there are in operation 500 lamps. The majority of these are operating upon 3,000 alternation (25 cycle) circuits. The average life of the glowers on 7,200 alternations (60 cycles) is about 800 hours; on 3,000 alternations the life is about 400 hours. Operation upon 3,000 alternations is a field into which the arc lamp has no access, and the use of incandescent lamps, especially of low candle power, on this frequency is particularly fatigu-

ing to the eye, because of the effort which the retina makes in following the fluctuations of light intensity with the alternating current wave. The fact that Nernst lamps are operative on 3,000 alternation circuits assumes considerable importance because no unnecessary complications are introduced into the power plant, where it is desirable to use this frequency for both lighting and power transmission. Alternating current circuits of 220 volts (nominal) are best for operating Nernst lamps. They are furnished to operate upon any voltage in this neighborhood.

The Nernst lamp is so much more satisfactory for operation on alternating current circuits that our energies are largely directed toward the supplying of the demand in that direction.

But you of the New England Cotton Manufacturers' Association who are deeply concerned with this question of properly illuminating your looms, your dye-houses, your print-works, your cloth rooms, and the like, will be interested, I am sure, in knowing more about the economy and steadiness and particularly the color of the light under consideration. As to economy, the power required by the Nernst lamp is about one-half of that used by the incandescent lamp, for equal illumination. Compared with the arc, the Nernst efficiency is slightly less, when considering the light emitted in all directions, yet for equal consumption of power, the superior distribution of the Nernst, combined with its absolute steadiness and pleasing color, give the impression of decided superiority in favor of the latter. After all, in many industries, this question of the economy of the lamp alone, while of considerable importance, is quite overshadowed by the economy in manufacture which may be effected by proper illumination of machines and work in progress. Avoidance of dense shadows is of utmost importance, especially in cloth rooms where the inspections are made. The accompanying photographs will give you an idea of the shadowless illumination possible by the use of Nernst lamps. The aisle of this dry goods store is illuminated by four three-glower or 250 watt lamps, furnished with sandblasted globes. The lamps in this case are spaced fifteen feet apart.

FIGURE 7. DRY GOODS STORE ILLUMINATED BY NERNST LAMPS.

FIGURE 8. STORE ILLUMINATED BY NERNST LAMPS.

FIGURE 9. SIX GLOWER LAMP WITH HOUSING REMOVED.

Our criterion of illumination is, of course, diffused daylight. When dependent upon artificial illumination, we wish to retain as far as possible the same characteristics as possessed by such daylight. The Nernst glowers operate at a higher temperature than the carbon filaments of incandescent lamps. The result is not only a great increase in the efficiency but in improved color, since a greater proportion of the rays emitted occupy a higher position in the solar spectrum. In the arc, violet and blue rays predominate, while with the incandescent lamp we find less of the blue, with orange predominant. The Nernst light occupies a position between the two, closely resembling diffused daylight, and is particularly adapted to the accurate discrimination of colors. Shades which differ slightly by daylight, lack tone and individuality under the incandescent lamp, but are nicely brought out when viewed by the Nernst lamp. This is well demonstrated by a piece of apparatus in which one-half of a band, made up of

FIGURE 10.

WITH INSIDE GLOBE LOWERED.

FIGURE 11.

WITH HOUSING LOWERED.

OUT-DOOR TYPE SIX GLOWER LAMPS.

strips of various colors and shades, is illuminated by Nernst and the other half by incandescent light. After seeing this I am certain you will all agree that the superiority in this respect lies overwhelmingly in favor of the Nernst. As to comparison with the arc lamp in this matter of color discrimination, it is related that a grocer of one of your New England towns exposed for sale some cranberries, and because they were illuminated by an enclosed arc, they were admired as the largest blueberries of the season.

FIGURE 12. OUT-DOOR TYPE SIX GLOWER LAMP.

As to care and maintenance, the average life of the glowers is 800 lamp hours, and from 2,000 to 3,000 lamp hours for the heaters. The life of the ballasts may be considered indefinite under ordinary conditions. A 5 per cent. rise in line voltage is entirely permissible. Continued running on 10 per cent. over voltage may somewhat impair their life.

To those of you who may not have followed the development of the Nernst lamp at all, the impression may linger that it is still in the experimental stage. This is erroneous. We now have operating (April 1, 1902), under widely varying commercial conditions, in the neighborhood of 400,000 candle power in

FIGURE 13. IN-DOOR TYPE SIX GLOWER LAMP.

Nernst lamps. These are used in stores, residences, factories, office and public buildings, as well as for street lighting.

That they are giving entire satisfaction is evidenced by the fact that at present our largest orders are from our customers.

The Nernst Lamp Company is occupying a large and well equipped factory which is at present turning out about 200 lamps per day and the present output of glowers is about 1,000 50-candle power glowers per day or 50,000 candle power.

Much interest has been awakened by the entrance of the Nernst lamp into the field of commercial lighting and occupying, as it does, a position between the incandescent and the arc lamp, nothing but the greatest success is predicted for it.

The PRESIDENT. Gentlemen, is there any discussion on the Nernst lamp? Mr. BEEBE will be very glad to answer any questions you may wish to put to him.

Mr. WILLIAM D. HARTSHORNE. Mr. President, I would like to inquire if a corresponding test has been made between daylight and the Nernst lamp on colors in a similar manner to that shown here for the difference between the effect produced by the Nernst lamp and the incandescent lamp?

Mr. MURRAY C. BEEBE. Why, yes, there has. It is pretty hard, of course, to make a test of that kind, and we have not conducted daylight into this frame of colors alongside of the Nernst lamp, but it has been the experience of every one who has tried to match colors at the dry goods stores and the like, that the colors appear under this light in almost their natural shade. I have some pictures here of a dry goods store illuminated by Nernst lamps, and I will be very glad to show them to you through the stereopticon, together with my other pictures. I will run through these very hastily.

[Mr. BEEBE proceeded to exhibit a large number of lantern slide views illustrating the mechanism of the Nernst lamp, including two views in a dry goods store taken by the light of the lamps themselves,]

Mr. EDWARD ATKINSON. Mr. President, I heard some suspicious words, not having listened to the first part of the paper, about "heaters" and "glowers". I would suggest to our friend that he send a Nernst lamp or two to our laboratory, so that we may find out what the words "heater" and "glower" mean.

Mr. CHARLES H. FISH. I would say, as perhaps an interesting point just now, that I had some of these lamps sent me some time ago at Dover, not to test, but to put up and try and see how we liked them. They were not sold to me, so far as I know; I think they were loaned; (I doubt if I ever return them). My electrician, after studying the situation carefully, ordered what

voltage he wished. The lamps came, and he brought one into my office one evening and screwed it into a socket above my desk. I had seen the lamp at Pittsburgh lighted, but I had never seen it in process of lighting and I had forgotten about this long time it took to light up. The electrician screwed the lamp in and turned the electric button, and then turned the button again, and looked confused, and went out and turned the circuit off and on, but no light. We discussed the matter some moments, and just about the time the electrician was beginning to think he was getting into a scrape, it suddenly burst out like the rays of the morning sun. It was very amusing. There was absolutely no light for a while — at least, there must have been some glow, but we did not discover what was up, and while we were considering what the trouble was, and what we had best do, whether we had best send the lamp back to Pittsburgh, it developed itself. That lamp has been burning in my office all winter, and it lights the office better than the cluster of five lamps which was directly over my desk. I do not mean to say that this lamp is giving more light than the five lamps, but for practical purposes, as I notice it in working in the office in the evening, this one lamp is better for me than the five incandescent lamps.

Mr. MURRAY C. BEEBE. I think it is a very good one; thank you.

The PRESIDENT, Is there any question to be asked Mr. BEEBE?

Mr. THOMAS H. SMITH. I would like to ask, Mr. President, is there any gain in this lamp; does it take less current to operate than other lamps?

Mr. MURRAY C. BEEBE. The efficiency of the Nernst lamp is very close to that of the enclosed arc. That is, actual photometric measurements will show an efficiency slightly less for the Nernst lamp than for the enclosed arc, taking the light given off in every direction — hemispherical candle power or spherical

candle power, to use the technical terms. We have in many instances replaced the enclosed arc lamp with the Nernst, and given greater satisfaction than where the enclosed arc was used. The efficiency for the lower hemisphere is slightly less than for the enclosed arc, but for a cone of about 60 degrees the Nernst lamp is far ahead. That is, the desk or floor illumination is far superior in actual watts per candle power.

Mr. THOMAS H. SMITH. Which costs the most for installation?

Mr. MURRAY C. BEEBE. Well, you can get all kinds of arc lamps. You can get arc lamps that are cheaper and you can get arc lamps that cost more.

The PRESIDENT. The installation, he wants.

Mr. MURRAY C. BEEBE. The installation, I should say, would be about the same as the enclosed arc. The cost at present of the 6-glower size, which we have substituted for the enclosed arc, is $25. The 3-glower size we are now getting $15 for; that is half the size of the one burning above in this hall; the 2-glower, $10, and the single glower, $6. That is the first cost. The cost of maintenance would be entirely favorable to the Nernst lamp when compared with the enclosed arc. The actual figures on the renewals have not been set; that is, on the cost of the several parts. That will be done, I think, this month. You may be sure that those prices will be such as to compete satisfactorily with both incandescent and arc. To show you that we are standing back of our lamps, I may say that up to the present time, although we have in continuous operation probably 8,000 glowers, we have thus far been renewing all glowers and heaters necessary free of charge, simply to show that we have faith in what we are doing. I refer to the Westinghouse interests, and they are standing back of the Nernst lamp.

Mr. W. B. SMITH WHALEY. Mr. President, I am using that lamp, and I am very much interested in the statement made by the gentleman. Do you mean to say (addressing Mr. MURRAY C. BEEBE) that the efficiency of a single glower is almost as great as that of a 1,200 candle power arc light.

Mr. MURRAY C. BEEBE. By no means.

Mr. W. B. SMITH WHALEY. That is the point I am inquiring about — whether the number of glowers making the candle power would be in the same proposition per watt hour, or a greater number.

Mr. MURRAY C. BEEBE. Why, the light given by a 6-glower light as compared with a single glower is about 6 to 1. It is slightly more, because the glowers are more efficient when operating side by side than when one is operating individually. The 6-glower lamp, 500 watts, is the one that we claim will give you as good an illumination as the ordinary enclosed arc. It consumes about the same amount of power, you see; 500 watts.

The PRESIDENT. We will now take up the reading of the next paper. The next paper on the programme, Supervision of Mills, by Mr. CHARLES W. DENNETT, is postponed until the fall meeting. The next paper on the programme, Weighting of Top Rolls, has not been received, and I do not think Mr. ROBINSON has come, so this is also postponed.

We will pass to the next paper, Viscose, As Applied to Textiles, by Mr. CHARLES N. WAITE. Mr. WAITE is not here, and the Secretary will read his paper.

VISCOSE, AS APPLIED TO TEXTILES.

CHARLES N. WAITE, 35th St. and Gray's Ferry Road, Philadelphia, Pa.

"Viscose" is the name applied to a peculiar solution of cellulose, discovered in 1892 by Messrs. Cross, Bevan & Beadle, of London, England. Any form of a pure cellulose, such as cotton, linen, or wood pulp, which has been freed from resinous and ligneous matters, is first mercerized by treating with a solution of caustic soda and is then subjected to the action of bisulphide of carbon in a closed vessel for from three to five hours; the small excess of uncombined bisulphide is allowed to evaporate into the air, and the resulting compound—known as the double zanthate of cellulose and soda, — is dissolved in water by rapid agitation. The resulting solution has many applications in the textile arts, since the cellulose may be regenerated in the form of filaments or as a coating on fabrics, by heat or by neutralizing the soda.

When viscose is used as a coating, the fabric is simply run through a mangle containing viscose solution of any desired strength; the fabric is then steamed, whereby the cellulose becomes so firmly fixed that if gray cloths are first treated with viscose they may afterwards be put through the usual bleaching processes without any loss of the attached cellulose. Cellulose thus applied gives a smooth linen-like feel to cotton fabrics.

Viscose may also be used as a binder for filling materials. If four pounds of china clay be mixed with one pound of dissolved cellulose, and if gray cloth be padded with this mixture and then steamed, the clay and cellulose are so firmly fixed that the

cloth may then be bleached as usual, without any loss of either the clay or the cellulose.

Viscose has been used for producing brocaded effects on print cloths, by applying the above mixture with engraved rolls. After fixing by steaming, the goods may then be printed in colors over the white pattern, giving the effect of printed brocades.

Viscose may be used as a binder for pigment colors which are not affected by an alkaline sulphide. Its binding effect is several times that of the best albumen.

A very interesting development in the use of viscose is the production of a new artificial fiber, of great lustre and strength. The solution made from wood pulp is forced under pressure through fine openings in a platinum disc; it issues from these openings into a neutralizing solution, and the cellulose solution immediately becomes a tough, rubbery filament. The number of openings in the disc may be almost any number. From each one a filament is formed, and the bundle of filaments is gathered over a hook and twisted by means of a centrifugal spinning device. After the spinning, the rubbery twisted filament is reeled into hanks, which are then stretched on rolls, and steamed in order to thoroughly regenerate the cellulose. After steaming, any remaining salts are washed out and the fibre is allowed to dry under tension, as in the case of mercerization of cotton. The fibre may then be bleached and dyed, like mercerized cotton. It withstands soaping and boiling without loss of lustre or strength. Its wet strength is one-half to two-thirds of its dry strength, but on drying its full strength is recovered.

The PRESIDENT. . The next paper on the programme, the last paper, is Japanese Cotton Mills, by Mr. TETSUTARO INUMARU, Tokio, Japan. The Secretary will please read this paper.

JAPANESE COTTON MILLS.

TETSUTARO INUMARU, Tokio, Japan.

In the following statistics, 1 yen is the equivalent of 50 cents in United States money and 1 sen is one one-hundredth of a yen, or one-half a cent.

The following report is submitted of the cotton weaving in Japan for the month of September, 1901:

Number of looms,	3,733	
Operating days,	26½	
Daily operating hours,	12½	
Cotton cloth woven,	3,961,220	yards.
Cotton per day per loom,	42.93	"
Cotton yarn consumed,	996,452	pounds.
Cotton yarn wasted,	27,546	"
Consumption of coal,	3,393,133	"
Price of coal (per 6 tons),	23.78	yen.
Horse powers,	1,425	
Coal consumption, per horse power per hour,	4.99	pounds.
Laborers, man,	580	
woman,	3,311	
Laborers' average wages, man,	34.99	sen.
woman,	20.98	"

The following table gives the statistics of the various Japanese cotton mills for the last six months of 1900.

REFERENCE TO TABLE.

The following is given in explanation of the table:

Location. About 90 per cent. of Japanese mills are located between north latitude 34°-36° and east longitude 130°-140°.

The principal seat of this industry is the city of Osaka, next Okayama, third Nagoya.

System. About 30 years ago the Japanese Government imported cotton spinning machinery from England as models of this industry; consequently most of the mills use English machinery.

"Boseki" means spinning, and "Boshoku" means spinning and weaving. Almost all mills take their names from that of the town or province in which they are located.

All of the mill companies are organized as stock companies with the limited liability feature.

According to Japanese commercial law, the limited company is to be recognized as a legal body when the stockholders pay in one-fourth of the stock subscribed. So "Amount of capital paid in" means the amount which has actually been paid by stockholders.

According to Japanese commercial law a limited company must set aside at least 5 per cent. of its profit as surplus.

"Real estate, etc." means land, buildings, machinery, etc.

The consent of the Government and the stockholders are required for the issue of bonds.

The National Bank of Industry is organized for the benefit of industrial enterprises and lends money in yearly installments (term limit is 20 years) taking real estate as its security.

"Loans from other banks, etc." means common loan with note, etc.

According to Japanese commercial law, the company must settle its accounts once a year at least, and most of them do this twice a year at the last of June and December, and a certain amount of profit and loss is carried forward, generally, to the next half year.

"Interest paid" is the interest paid for all loans.

Almost all Japanese mills work both day and night.

"Running expenses" is the expense from July 1st to Dec. 31st, 1900.

The settlements for the last half of the year 1900 show a loss for most of the mills. This is due to Chinese trouble in 1900 and also to financial condition in Japan.

INDEX.

A

Absorption of Water by Bricks . 157
Active Members, List of 13
Adams, Alfred E., Chairman to Award Association Medal . . 105
Adams, Alfred E., Elected Vice President 124
Advertisements, Income of . . . 103
Air, Hydraulic Compression of, William O. Webber 174
Air Motors 176
Alphabetical List of Members . . 13
Amendment to Charter 4
American Telephone and Telegraph Co., Resolution of Thanks to 115
Arkwright, Spinning Invention . 205
Arthur, Thomas, Compressed Air 182
Artificial Silk, Chas. N. Waite . 298
Associate Members, List of . . 29
Association Medal 87
Association Medal, Awards of . 105
Association Scholarship 88
Association Scholarship, Condition of 91
Assyrian Water Bellows 179
Atkinson, Edward, Discussion on Nernst Lamp 294
Atkinson, Edward, Insurance Engineering 126
Attendance at Boston Meeting . 61
Auditor's Report 102
Austrian Regulations on Chimneys 150
Baloche Compressed Air . . . 182

B

Bean, C. Enos, Elected an Active Member 119
Beebe, Murray C., Cost of Nernst Lamp 296
Beebe, Murray C., The Nernst Lamp in Industrial Establishments 279
Beebe, Murray C , Resolution of Thanks to 115
Bellows, Water 179
Bilbrough, William H., Elected an Active Member 119
Boston, Mayor of, Address of Welcome 77
Boston Meeting, Attendance at . 61
Brick Factory Chimneys: Some Features of their Construction, William Wallace Christie . . 149
Bricks, Absorption of Water by 157
Bricks, Radial 153
Bricks, Strength of . . . . 151—156
Bricks, Water Proofing of . . . 157
Briggs, George T., Elected an Active Member 119
Brooks, Christopher P., Chairman of Committee to meet Lancashire Manufacturers' Association 113

Brooks, Christopher P., New Process of Spinning 276
Bryant, C. B., Telegram from . 110
Burgess, Robert, Cops Spun on Frame 276
Burke, Edward N., Committee on Nomination of Officers . . 77
Burke, William Alvord, Sketch of 56
Business Organizations, Use of, Samuel T. Hubbard 83
By-Laws 5

C

Call to Seventy-second Meeting . 71
Card Catalogue 95
Cellulose, Substitute for Silk, Charles N. Waite 298
Cement, Strength of 154
Chapin Mines, Michigan, Compressed Air at 175
Charter 3
Chimneys for Factories, William Wallace Christie 149
Chimneys, Induced Draft Substitute for 248
Chimneys, Stability of 163
Christie, William Wallace, Brick Factory Chimneys; some Features of their Construction . . 149
Christie, William Wallace, Resolution of Thanks to 115
Collins, Hon. P. A., Mayor's Address of Welcome to the Boston Meeting 77
Collins, Hon. P. A., Resolution of Thanks to 114
Combers, Joseph Nasmith . . . 227
Combing Machine, Joseph Nasmith 227
Comer, B. B., Interstate Commerce 115
Commerce, Interstate 115
Compressed Air, Efficiency of . 191
Compressed Air, Pre-heating of . 177
Compression of Air, Hydraulic, William O. Webber 174
Congressional Hearing on Yarn Numbering 88
Constitution and By-Laws . . . 5
Cost of Nernst Lamp, Murray C. Beebe 296
Cost of Transmission of Power by Compressed Air 193
Cotton Crop, Estimates of . . . 84
Cotton Exchange, Address by President, Samuel T. Hubbard 83
Cotton Ginning, Monograph on . 99
Cotton Market, Estimates of . . 84
Cousens, Lyman M., Elected an Active Member 119
Cowell, Richard, Elected an Active Member 119
Crosby, William W., Methods of Cotton Textile Instruction . 131
Crosby, William W., Resolution of Thanks to 115

D

Dallin, Cyrus E., Sculptor of Whitney Tablet 93
Damrell, John S., Fire Tests of Terra Cotta 170
Deed of Trust of Association Scholarship 89
Deed of Trust, Whitney Tablet . 94
DeWolf, John O., An Electrically Driven Cotton Mill . . . 239
Draper, C. H., Stoppage of Looms 213
Draper Loom 213
Drew, Harry K., Elected an Active Member 119
Dunn, Improvement in Flyers . 206
Dutcher, Frank J., Elected an Active Member 120

E

Earnings of the Association . . 102
Efficiency of Compressed Air . . 191
Election of Members 119
Electric Drive for Cotton Mills, W. B. Smith Whaley 258
Electric Lighting of Mills, Murray C. Beebe 279
Electric Motors, Subdivision of . 266
Electric Transmission, Cost of . 198
Electric Transmission of Power, Cost of 261
Electric Transmission of Power, John O. DeWolf 239
Electric Transmission of Power, W. B. Smith Whaley 258
Electrically Driven Cotton Mill, John O. DeWolf 239
Eli Whitney County Club . . . 93
English Delegation, Address by Henry Higson 125
English Delegation to Meeting . 113
European Textile Education . . 134
Everly, D. A., Elected an Active Member 120

F

Factory Chimneys; Some Features of their Construction, William Wallace Christie . . 149
Farnum, Herbert R., Sketch of . 54
Finances of the Association, Table of 104
Fire in Association Office . . . 99
Fire Brick, Strength of 156
Firth, William, Association Scholarship 88
Fish, Charles H., Award of Association Medal to 105
Fish, Charles H., Discussion on Nernst Lamp 294
Fish, Charles H., Elected President 124
Fish, Charles H., President's Address 79
Floors, Mill 242
Flyers, Fay H. Martin 204
Former Officers 10
Foster, M. F., Committee on Nomination of Officers 77
Frame, Spinning Cops on . . . 276
Freight Rates on Cotton 85
Friction of Mill Transmission . . 261
Frizell Air Compressor 180

G

General Electric Generators at Olympia Mills 250
Geographical List of Members . 35
Ginning of Cotton, Monograph on 99
Glowers in Nernst Lamp 281
Goetze, Otto, Elected an Active Member 120
Grant, George P., Jr., Committee on Election of Members . 122
Green, Samuel M., Elected an Associate Member 121
Green, William A., Fire Tests of Terra Cotta 170
Greene, Edwin Farnham, Elected an Associate Member 121
Grinnell Mills Spinning Cops on Frames 277
Guests of the Association . . . 111
Guides and Thread Boards for Wet Twisting, Lewis T. Houghton 216
Gulliver, Arthur H., Electric Transmission of Power . . . 263
Gulliver, Arthur H., Resolutions of Thanks 114

H

Hartshorne, William D., on Compressed Air 201

Hartshorne, William D., Discussion on the Nernst Lamp . 294
Heating of Olympia Mills . . . 242
Heilmann Comber 227
Higson, Henry, Address on Behalf of the Lancashire Manufacturers' Association 125
Hill, Ernest L., Elected an Active Member 120
Hill, John, Sketch of 58
Hill, William H., Elected an Active Member 120
Hobbs. William Henry, Elected an Active Member 120
Honorary Members, List of . . 13
Houghton, Edward W., Elected an Active Member 120
Houghton, Lewis T., Thread Boards and Guides for Wet Twisting 216
Howe, Frederic W., Elected an Associate Member 121
Hubbard, Samuel T., Resolution of Thanks to 114
Hubbard, Samuel T., Use of Business Organizations . . . 83
Humidifiers 243
Humidity affecting Fibres . . . 141
Hydraulic Compression of Air, William O. Webber 174

I

Index to Transactions 95
Induced Draft at Olympia Mills . 248
Insurance Engineering, Edward Atkinson 126
Interstate Commerce 115
Inumaru, Tetsutaro, Japanese Cotton Mills 300
Inumaru, Tetsutaro, Resolution of Thanks to 115

J

Jackson, Daniel, Elected an Associate Member 122
Japanese Cotton Mills, Tetsutaro Inumaru 300

K

Kidder, Frank E., Tests on Terra Cotta 171
Kimball, William N., Elected an Active Member 120
Kipper, Emil, Elected an Active Member 120
Kitson, Charlotte P., Donation to Lowell Textile School . . . 145
Kitson Hall at Lowell Textile School 145
Knight, Albert, Sketch of 54
Knight, Stephen A., Committee on Nomination of Officers . . 77
Knots and Knot Tying, Robert C. Webster 210

L

Lancashire Manufacturers' Association, Delegation of 113
Lee, Calvin H., Elected an Active Member 120
Libby, Charles F., Elected an Active Member 120
Lighting of Mills by the Nernst Lamp, Murray C. Beebe . . . 279
Location of Membership 52
Looms, Stoppage of, C. H. Draper 213
Loring, Sanford E., Elected an Associate Member 122
Loring, Sanford E., Factory Chimneys 165
Loring's Terra Cotta, Test of . . 170
Losses in Electric Transmission of Power 275
Lowe, Arthur H., Discussion on Textile Instruction 146
Lowell Textile School, Methods of Instruction 144
Lyall, William L., Losses in Electric Transmission 268

M

MacColl, James R., Elected Director 124
Machine Tied Knots 212
Magog Compressed Air Plant . 178
Manchester Mills, Electric Transmission of Power 276
Martin, Fay H., Flyers 204
Mauriac, Percy H. de, Elected an Associate Member 122
Mayor of Boston, Hon. P. A. Collins, Address of Welcome . 77
McIntosh and Seymour Engines at Olympia Mills 249
Mead, Albert Spaulding, Georgia School of Technology, Received Student's Medal . . . 88
Mechanics Fire Test of Terra Cotta 170
Medal, Association, Awards of . 105
Members, Alphabetical List of . 13
Members, Election of 119
Members, Geographical List of . 35
Membership, Changes in 96
Membership, Chart of 99
Membership, Location of . . . 52
Membership, Table of 97
Membership, Total 34
Memorial Sketches 53
Mercer, Joseph, Elected an Active Member 120
Metallic Thread Board, Whittum, Richard Thackeray 222
Methods of Cotton Textile Instruction, William W. Crosby . 131
Microscope Applied to Fibres . . 140
Mill Floors 242
Moisture Affecting Fibres . . . 141
Mont Cenis Tunnell, Compressed Air at 174
Montgomery, J. R., Elected Director 124
Morison, George B., Elected an Active Member 120
Mortar, Strength of 154
Motors, Electric, Subdivision of 266

N

Nasmith, Joseph, A New Combing Machine 227
Nasmith, Joseph, Resolution of Thanks to 115
Necrology of Past Members . . 72
Neff, Robert W., Elected an Associate Member 122
Nernst Lamp in Industrial Establishments, Murray C. Beebe 279
Nernst Lamp Company, Resolution of Thanks to 115
New Bedford Textile School Scholarship 73
New England Telephone and Telegraph Company, Resolution of Thanks to 115
New York Cotton Exchange, Address by President, Samuel T. Hubbard 83
Nomination of Officers 123
North, S. N. D., Donor of Monograph on Cotton Ginning . . 99
Northrop Loom 213
Notice of Meeting, Seventy-two 72
Numbering of Yarn, Instruction in 146

O

Offenbach, Compressed Air at . 174
Officers 9
Officers, Election of 124
Officers, Nominating Committee for 77
Olympia Cotton Mills, Electric Transmission of Power at . . 239

P

Paine, Sidney B., Award of Association Medal to 108

Paine, Sidney B., Losses in Electric Transmission of Power 275
Paine, Sidney B., Subdivision of Motors in Mills 266
Parker, Bartholomew Moore, Lowell Textile School, Received Student's Medal . . . 88
Parker, Walter E., Committee on Nomination of Officers . . 77
Parish, William F., Jr., Elected an Associate Member 122
Past Officers 10
Pennell, William D., Elected Director 124
Periodicals at Headquarters . . 100
Piers, Strength of 155
Pomeroy, James Voorhees, Philadelphia Textile School, Received Student's Medal . . . 88
Popp System of Compressed Air 174
Portsmouth, England, Compressed Air at 175
Power, Cost of Transmission by Compressed Air 194
Power, Electric Transmission of, John O. DeWolf 239
Power, Electric Transmission of, W. B. Smith Whaley 258
Power House at Olympia Mills . 245
Pratt, Herbert L., Committee on Nomination of Officers . . . 77
Pre-heating of Compressed Air . 177
President's Address, Charles H. Fish 79
Prest, George E., Elected an Active Member 120
Prest, Harry B., Elected an Active Member 121
Prest, John E., Electric Transmission of Power 262
Programme of Seventy-second meeting 74
Prussian Laws on Chimneys . . 164

R

Radial Bricks 153
Ramsbottom, John W., Elected an Active Member 121
Resolutions of Thanks 114
Richards, John Bion, Elected an Active Member 121
Roberts, C. E., Auditor's Report 102
Robinson, William H., Elected an Active Member 121
Rollers for Spinning, Invented by John Wyatt 204
Roman Water Bellows 179
Rope Transmission of Power, Cost of 261

S

Sager, Alfred, Elected an Active Member 121
Saint Anthony Falls, Compressed Air at 181
Sanderson, Richard W. B., Elected an Active Member . . 121
Sanford, Arthur Engene, Lowell School of Design, Received Student's Medal 88
Scholarship, New Bedford Textile School 73
Scott, Emma K., Donation to Lowell Textile School 145
Searls, Albion K., Elected an Active Member 121
Secretary's Report 87
Shaw, Oliver L., Fire Tests of Terra Cotta 170
Shaw, William N., Elected an Associate Member 122
Silk, Artificial, Charles N. Waite 298
Smith, J. C., Committee on Election of Members 122
Smith, Thomas H., Discussion on Nernst Lamp 295

Solvay Process Company, Chimneys of 169
Southern Cotton Spinners' Association, Telegram from . . . 110
Southwick Hall at Lowell Textile School 144
Special Act for Association . . . 4
Spencer, Sheldon S., Sketch of . 53
Spinning Cops on Frame 276
Spinning, New Process of, Christopher P. Brooks . . . 276
Spinning Rollers, Invented by John Wyatt 204
Stability of Chimneys 163
Standard Yarn Numbering . . . 88
Statistics of Japanese Cotton Mills 301
Steam Boilers at Olympia Mills . 246
Stearns Company, Syracuse, Chimney of 165
Stoddard, George H., on Water Proofing Bricks 157
Student's Medal 88
Sturtevant Induced Draft . . . 248
Sturtevant System of Heating . 242

T

Tablet, Whitney 93
Taylor, Charles H., Compressed Air 183
Telephone Service, Courtesy of . 72
Terni Steel Works, Italy, Compressed Air at 175
Terra Cotta, Strength of 156
Terra Cotta, Test of 170
Tewksbury, George C., Elected an Associate Member 122
Textile Education in Europe . . 134
Textile Education, Methods of Cotton, William W. Crosby . 131
Thackeray, Richard, Whittum Metallic Thread Board . . . 222
Thanks, Resolutions of 114
Thread Board, Whittum Metallic, Richard Thackery 222
Thread Boards and Guides for Wet Twisting, Lewis T. Houghton 216
Tolman, James P., Interstate Commerce 118
Tramway Compressed Air . . . 177
Transactions, Index to 95
Transmission, Electric, of Power, John O. DeWolf . . . 239
Treasurer's Report, C. J. H. Woodbury 101
Trust Deed of Association Scholarship 89
Trust Deed of Whitney Tablet . 94
Twisting, Wet, Thread Boards aud Guides for, Lewis T. Houghton 216
Tying Knots, Robert C. Webster 210

U

Use of Business Organizations, Samuel T. Hubbard 83

V

Ventilation of Mills 242
Vienna, Compressed Air at . . . 174
Viscose as Applied to Textiles, Charles N. Waite 298

W

Waite, Charles N., Resolution of Thanks to 115
Waite, Charles N., Viscose as Applied to Textiles 298
Walmsley, Herbert E., Elected Vice-President 124
Warren, J. F., Elected an Associate Member 122
Water Absorbed by Bricks . . . 157
Water Bellows 179
Water-Proofing Bricks 157

Watertown Arsenal Tests of Strength of Bricks 151
Wattles, Joseph Warren, Sketch of 55
Weaver's Knots 211
Webber, W. O., Hydraulic Compression of Air 174
Webber, W. O., Resolution of Thanks to 115
Webster, Robert C., Elected an Associate Member 122
Webster, Robert C., Knots and Knot Tying 210
Weight of Fibres Affected by Moisture 141
Wies, George A., Elected an Active Member 121
Winchester, William E., Elected an Active Member 121
Wind Pressure on Chimneys . . 150
Whaley, W. B. Smith, The Electric Drive for Cotton Mills . . 258
White, Alphonso F., Elected an Active Member 121
Whitman, William, Representative of Association at Congressional Hearing on Yarn Numbering 88
Whitney, Eli, Country Club . . 93
Whitney Tablet 93
Whittum Metallic Thread Board, Richard Thackeray 222
Wood, Nelson Allen, New Bedford Textile School, Received Student's Medal 88
Woodbury, C. J. H., Secretary's Report 87
Woodbury, C. J. H., Treasurer's Report 101
Wyatt, John, Inventor of Spinning Rollers 204

Y

Yarn Numbering, Standard . . 88

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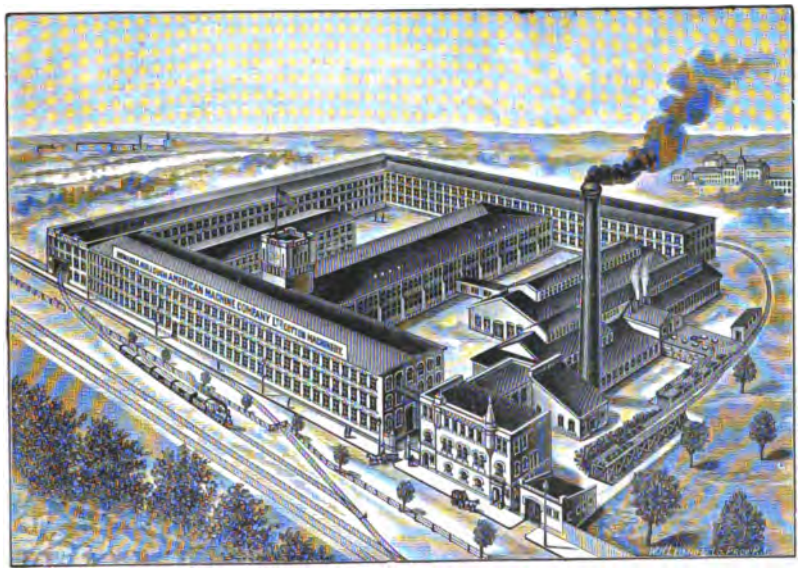

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WORSTED DRAWING on FRENCH SYSTEM.
GEGAUFF COTTON COMBER.

EGYPTIAN COTTON

FROM

CARVER BROS. & CO., Ltd., Alexandria and Liverpool.

The Roundlap Bale at the Mill.

In connection with the tests reported by Mr. Wm. S. Southworth and Mr. Oscar B. Truesdell at the Pan-American meeting of the New England Cotton Manufacturers' Association (see pages 219, 220, 223, of Volume 71 of the Transactions) the testimony of European spinners as to the advantages of The American Cotton Company's Roundlap Bale is highly interesting.

The organ of the Austrian Spinners' Association in September, 1901, published an analysis of letters received from the owners of more than 2,000,000 spindles relative to the merits of this package.

"Some important mills," the Austrian Spinners' organ says, "which have consumed large quantities of Roundlap bales, affirm that these bales give a better outturn than the ordinary bales, taking the same class and the same cleanliness. * * * Several spinners have, in fact, asserted that Roundlap bales are, almost without exception, free from sand."

"With reference to tare," to quote again, "it is generally admitted that the 1 per cent. allowed by The American Cotton Company is sufficient. One mill observes that the tare this season has been greater than ever before, never, however, reaching 1 per cent."

The Austrian Spinners' organ further says: "Our belief is that the Roundlap bale (or any other package possessing the same characteristics) will eventually bring about a thorough reform in the freight and insurance tariffs, thereby diminishing the cost of production for the European mills. This will enable the latter to compete on a more advantageous footing with the American mills."

The European market will readily absorb every Roundlap bale made.

American spinners who compete with European mills should not overlook the important advantage which the use of Roundlap bales confers.

New England mills supplied by the Howel Cotton Co., 831 Exchange Building, Boston.

THE AMERICAN COTTON COMPANY,

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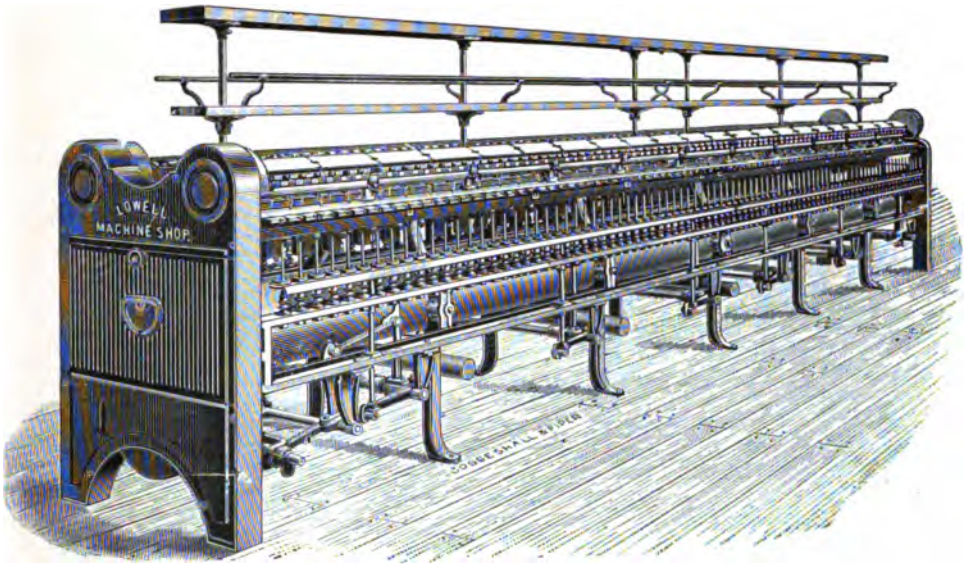

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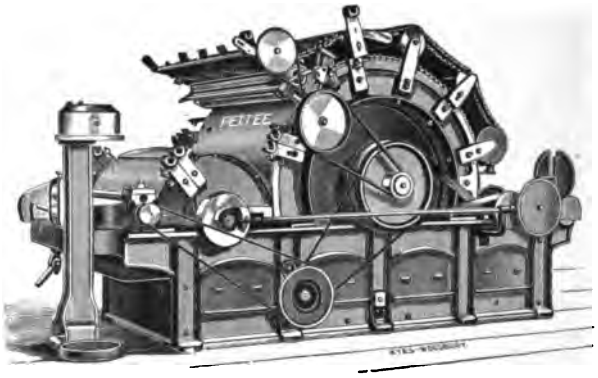

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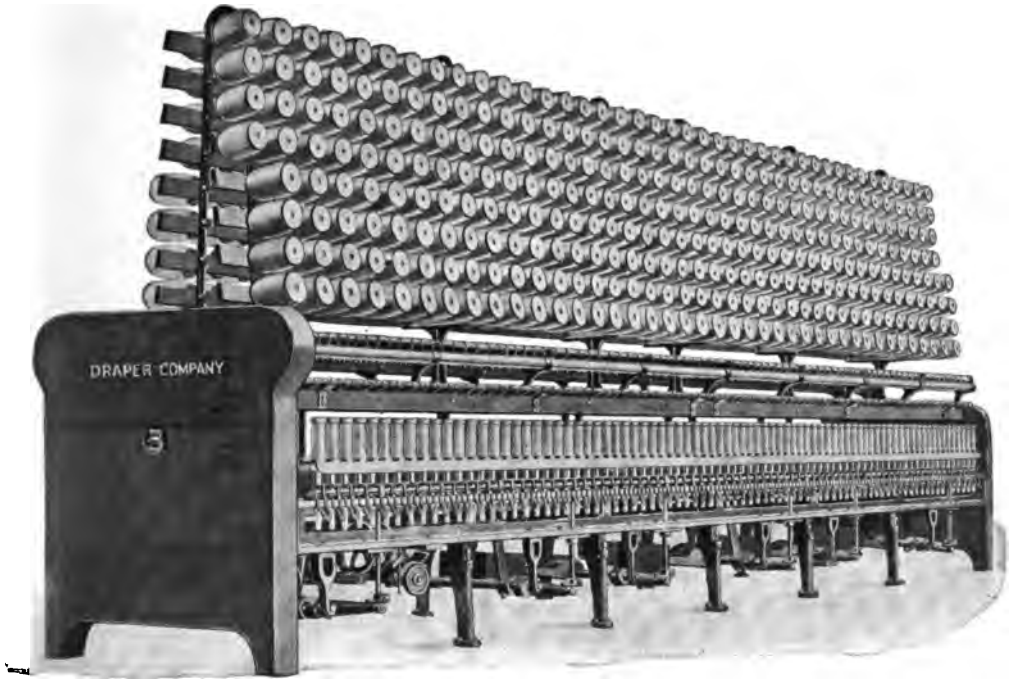

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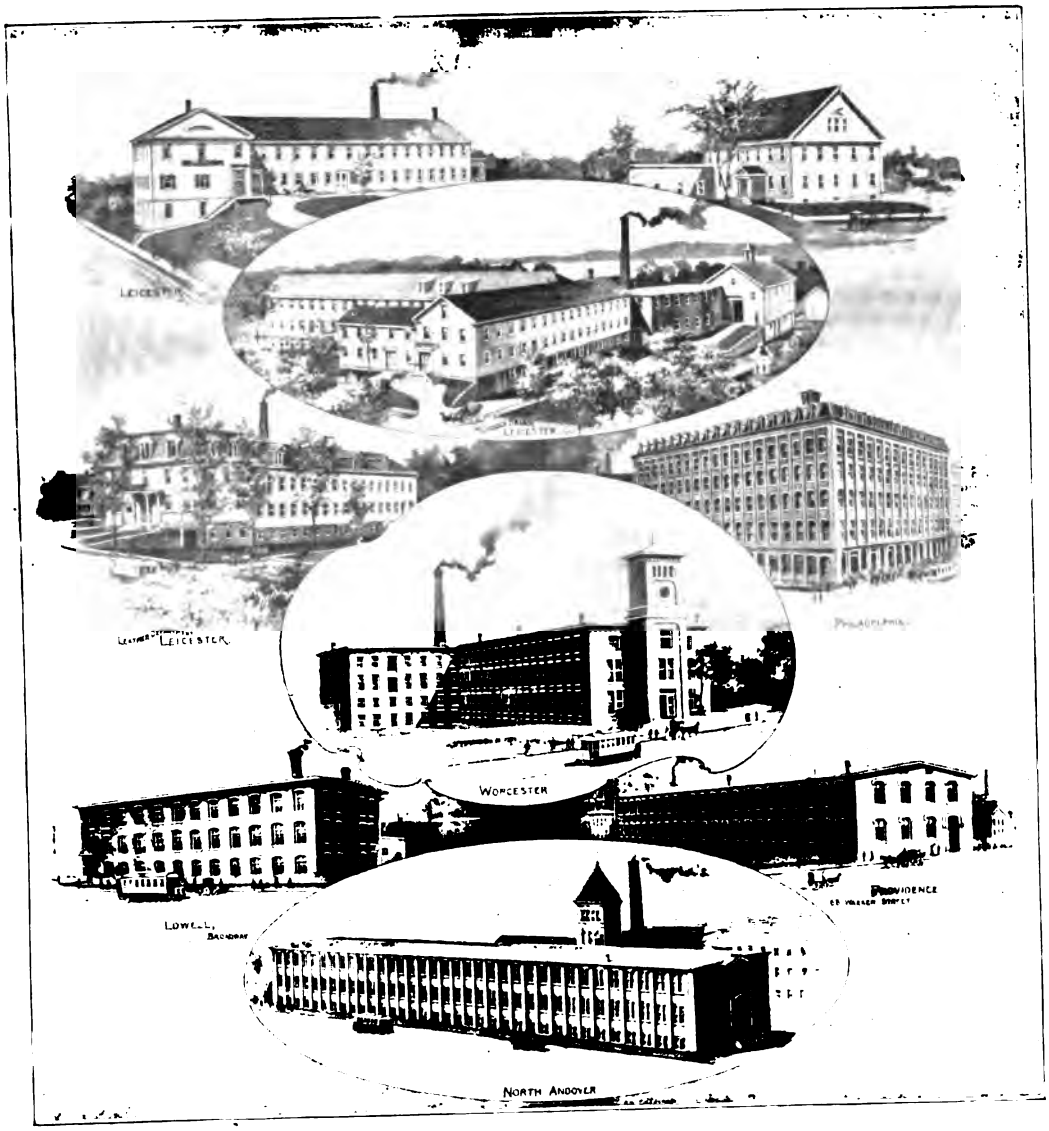

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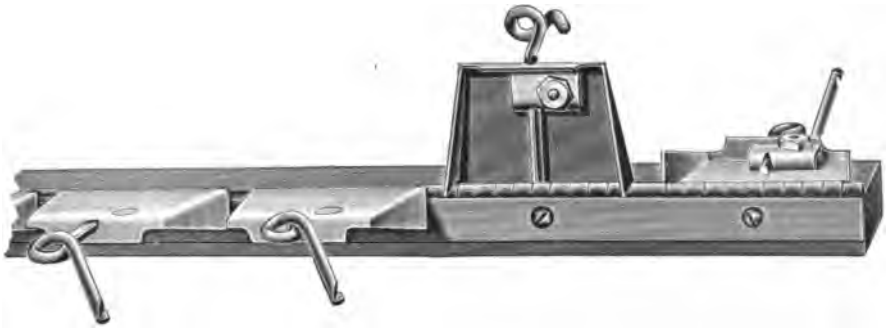

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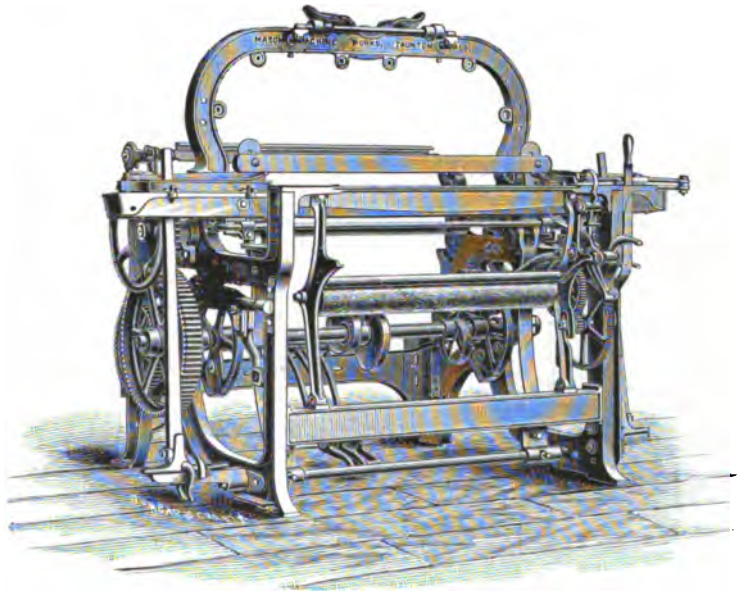

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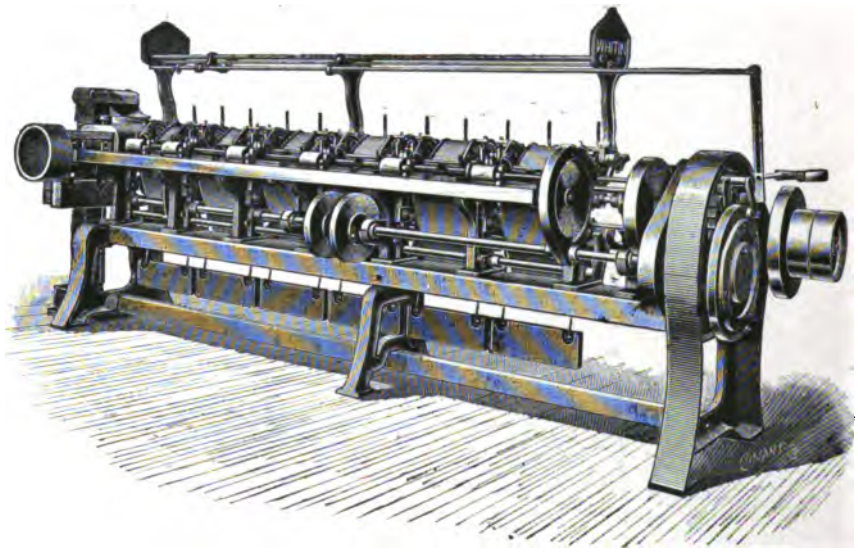

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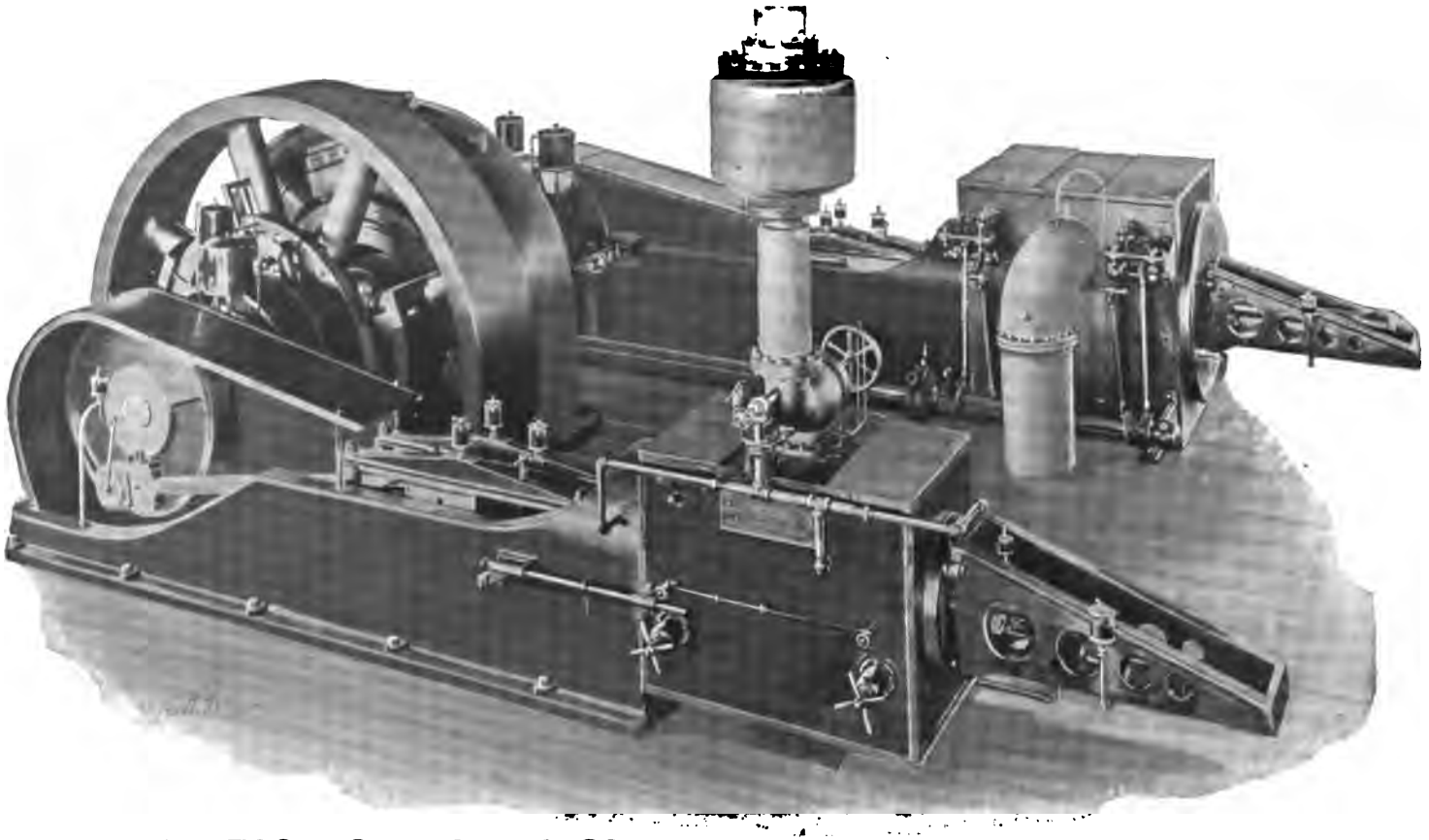

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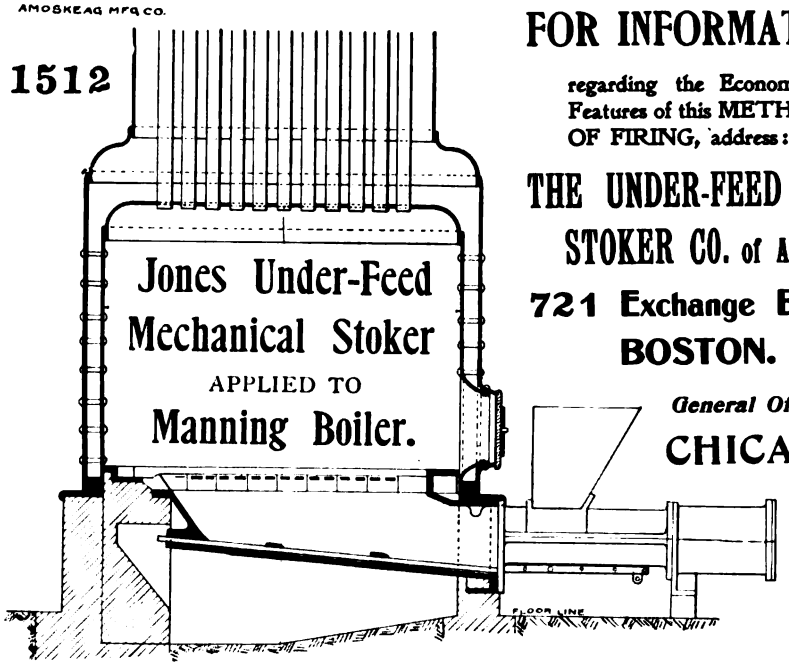

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